SCHOOL SCIENCE AND MATHEMATICS

VOL. XLI JANUARY, 1941 WHOLE NO. 354

A NEW EDITOR FOR BIOLOGY

In January 1922 the name of Mr. Jerome Isenbarger first appeared on the editorial staff of SCHOOL SCIENCE AND MATHEMATICS. For eighteen years his good judgment and devotion to editorial duties have contributed much to the success of this journal and have gained for him a host of professional friends all over the nation. His administrative duties as Assistant Dean of Wright Junior College have increased with the rapid growth of the college and now demand all his time.

His successor in the Editorship for General Biology is by no means a stranger to biologists and biology teachers. We present Professor John E. Potzger of Butler University, author of text-books in general science and nature study, of text-activity books and guides for the study of birds and trees, contributor to numerous science journals, member of Sigma XI, Botanical Society of America, Ecological Society of America, and other scientific societies, and a teacher with many years experience in all grades from elementary school to graduate classes. Mr. Potzger graduated from Butler University in 1927 and received his master's degree from the same institution four years later. In 1932 Indiana University awarded him the Ph.D. degree. Since then he has completed a number of important research problems, has taken special summer work at Ohio State University and with Dr. A. J. Grout at Newfane, Vermont. During the past summer he served with the University of Wisconsin Biological Survey. He has been an active member of the Indiana Academy of Science and the Central Association of Science and Mathematics Teachers for many years. He is also an accomplished musician. Our Department of General Biology continues with a progressive leader.

SCIENCE, MATHEMATICS AND SAFETY*

SIDNEY J. WILLIAMS

Director, Public Safety Division, National Safety Council, Chicago

Science is so interwoven into everything we have and everything we do in the modern world that it necessarily plays a large part both in causing and in preventing accidents. I shall discuss, first, the general relationship between science (including mathematics) and safety; then, what can science do for safety; and finally, what can safety do for science or, more exactly, for the teaching of science in the schools.

In the relationship of science to safety the former is a means while the latter is an end. For nearly all of us, safety is one of the objectives of satisfactory living, though not the only or the chief one. This is true of safety in the larger sense—freedom from poverty, disease, war and all the ills that flesh is heir to. It is true equally of safety in the more limited sense of freedom from or protection against accidental deaths and injuries and accompanying economic losses. In simpler language, no one wants to be killed or hurt, to have his car wrecked or his house burned down; nor do most of us want to have anyone else killed or hurt or his belongings destroyed.

We do not carry this to the absurd extreme of putting safety above everything else. If we did, we should never travel, skate, swim, play golf or tennis, light a fire, hang a picture, or go up or down stairs, because all of those things involve some hazard. None of us wants a "safety first" existence, I am sure; nor does the National Safety Council ever use that term. What we want is *reasonable* safety. We don't want our journeys, by rail or air or water or road, to end in a wreck. We don't want our work, our play or any other part of our living to be interrupted and thwarted through anyone's carelessness or neglect. We want the inherent hazards of the highway, the work-place, the home, to be reduced to a minimum, and then that we and our fellow users, whatever we are seeking to do, shall do it properly and with due regard for the safety of all. We don't want the risks we take to be larger than they need be, or out of proportion to the expected gain. Only a few things in life are worth dying for.

Now, it is obvious that the physical sciences in particular have given us most of the tools which we use, for good or ill, in

* An Address before the Central Association of Science and Mathematics Teachers, Cleveland, Ohio, Nov. 22, 1940.

our daily living. In general it is physical forces, and the machines they run, that get us into trouble or keep us out, depending on how we use them. We can hardly charge either pure mathematics or the biological and social sciences with helping to get us into trouble but, so far, psychology, politics and ethics have been only moderately successful in keeping us out.

What has science done for safety? It has protected us against many of the hazards as well as the discomforts and limitations of earlier generations. It has given us air-conditioned palaces to live and work in; luxury liners for dug-out canoes and streamlined trains, automobiles, and airplanes for ox-carts and stagecoaches; hydraulic, steam, electric and gasoline power—and some day atomic power—beyond the wildest dreams of Aladdin.

At the worst, these modern miracles have done mankind far more good than harm. But they have harmed us too. Or rather, they have given us new ways to harm ourselves, have magnified the tragic results of our peccadillos, and put a heavy penalty on ignorance.

Once, a man could get drunk without doing much harm. He could stagger from the tavern into his buggy and Old Dobbin would take him home. Now the drunk and the semi-drunk, aided by the automobile, kill and cripple themselves and the rest of us in alarming numbers. Your great grandfather could fall out of his cottage window and only infrequently break his neck, but not so if you live on an upper floor of this hotel. The punch press and the buzz saw exact a terrific price for a moment's inattention. A wire carrying 1,000 or 100,000 volts looks like any other wire and a deadly chemical may look like some new beverage, but woe to us if we touch them.

So the scientist that created these demons must protect us against them, as our five senses do not. It is not enough for the scientist to arrange things so that we can, with skill and constant vigilance, safely operate an automobile, a punch press or a dynamo; if existence depended on constant vigilance and skill, few of us would be here tonight. It is the job of the scientist so to imprison these giant forces that they cannot turn and rend us the moment we look the other way.

Thanks to the social and economic pressure of the modern safety movement, scientists, especially in industry, have done this to a great extent. They still have much to do. Automobiles, airplanes, industrial and home and farm machinery, all the apparatus of living must and will be made ever safer.

Psychology has contributed much to safety by helping us to understand why people do things they shouldn't, and how we can stop them. Psychology is a junior science and not everything put forward in its name in the highway traffic field, for example, is valid either scientifically or practically. But the basic principles of human motivation do help us greatly in dealing with the high accident driver or worker.

Political science should likewise help our safety efforts on the national, state and community levels. A few far-sighted political scientists (I could count them on the fingers of one hand) have indeed made such contributions, but in general it has been the other way—rather, the safety movement has contributed to better government and also to better industrial relations. Perhaps this is because politics is still an art rather than a science.

Finally, what can safety do for science? For the continued progress of science as such, nothing. For the teaching of science, a great deal.

Safety can vitalize the teaching of all the sciences, physical, biological, social.

Why do we skid if we try to stop or turn too quickly on a slippery pavement? Newton's first law of motion, of course. (Physicists and engineers, who understand the laws of motion, should have few automobile accidents; psychologists, who understand human behavior, should have none at all.)

Why are we likely to fall if we step on a round pencil left lying on the floor? Because rolling friction is less than sliding friction.

If I lean out too far from the top of a ladder, why does the ladder tip over? Because the center of gravity is outside the base.

If a car going 40 (or 60) miles an hour runs into a concrete abutment, and another car falls from the roof of a building onto the street below, and the impact is the same in both cases, how high is the building? That one takes some physics and some mathematics too, and teaches a good safety lesson.

Where should we and shouldn't we go, in a thunder storm? Are lightning rods really any good? Is it smart to turn on the electric light while standing in the bath tub? What happens—both physics and physiology—if we get an electric shock? What happens when we apply resuscitation? Why do we treat a person who has been under water the same as one who grabbed a live wire?

If I am driving 20 miles an hour, and a child runs into the street 50 feet away, can I stop before hitting him? What if I am

going 25, or 30? What if it is raining? Or if one of my four brakes isn't working? Or I have had three drinks? Or the radio is telling me of a long forward pass? Physics, physiology, mathematics, perhaps a little psychology.

Why do we have hand rails on stairs and not in hallways? That runs into the whole physiology of balance.

What is a safety match, and why? Physics and chemistry.

Why mustn't workmen in a powder plant have metal nails in their shoes? Do such buildings have light or heavy roofs and walls? What kind of fire extinguishers do we use on a burning waste basket, a burning automobile, a burning kettle of grease, a short circuited electric motor? What kinds of body burns are there and what do we do for them?

Why are highway speed limits lower in Massachusetts than in North Dakota? The answer is partly in geography, partly in anthropology.

Why do we have school fire drills and not just fire alarms? Psychology.

Accident statistics for the nation, the state, the city or the school offer innumerable exercises in mathematics, including rates, proportions, and the construction of graphs.

And finally, why do we have traffic laws, building laws, factory laws? Who made them, and what can we do if we don't like them? Can the policeman put us in jail?

All these questions, and hundreds like them, mean something to the boy or girl in school because they deal with situations in his everyday life. At the same time the answers to them run right down to the roots of all the sciences. Perhaps every one of you here tonight is already using—within reasonable limits of course—the type of approach which I, not a teacher, have only crudely indicated. If so, your students are fortunate indeed. There was very little of this approach in the schools I went to; there is more today but still, in my layman's opinion, not enough.

I should like in closing to emphasize the political and social science aspect suggested in my last question on laws, police and courts. The educational atmosphere nowadays is super-heated with discussions on education and democracy. Whatever we may think of some of the current arguments, at least the schools have gone a long way since my 7th grade days when the study we called "Constitution" consisted chiefly in memorizing that great document.

We all agree, I am sure, that democracy and citizenship must be taught not in terms of what Hitler is doing to the Jews but of what my neighbor and I are doing to each other. I submit that by far the most important thing my neighbor and I do to each other is how we behave on the highway, both of us driving, or one of us on foot. The only point of contact between the average boy or girl and his government is the traffic policeman. Traffic situations provide a universal language through which we can show to old and young alike the supreme necessity in our highly integrated modern world of these two things: fair play and kindness to others, or let us say self-control on the individual level; and social control through democratic, representative self-government. If we can teach our young people to be good citizens on the highway there is a pretty fair chance that they will be good citizens everywhere.

NEW MAGNESIUM SULFATE PLASTER

Though chemically the same as plaster of Paris, a new gypsum plaster, described at the meeting of the American Institute of Chemical Engineers, is about twice as strong as the old-fashioned article. In fact, it approaches Portland cement in strength.

The new product was announced by E. P. Schoch and William A. Cunningham of the University of Texas. It is prepared, they explained, by heating gypsum in a magnesium sulfate solution, whereas plaster of Paris and ordinary wall plaster are made by the dry calcination or burning of gypsum.

Experiments in a small plant indicate, they stated, that it can be made at a cost of $8.82 per ton, a figure that may be reduced by large-scale production. Probably the magnesium sulfate plaster will find its chief application in wall board, tile and other factory cast products.

BIG TEXAS STORM BROUGHT BENEFITS TO OTHER PARTS OF COUNTRY

The big storm that crippled transportation and wrecked wires in Texas in late November brought benefits to other parts of the country where conditions were not so extreme.

In the higher western mountains there were heavy snows, which will pay dividends next year in terms of irrigation, water for livestock, and protection against forest fires. On the southern plains, the rain drowned still deeper the unhappy memories of Dust Bowl days.

Rains and snows in the Corn Belt have stopped late harvesting of corn and soybeans, but have replenished soil moisture in many places where it was badly needed. Winter wheat has benefited greatly, especially in the Ohio valley, where a late fall drought had long outstayed its welcome.

THE WORK OF THE BUREAU OF EDUCATIONAL RESEARCH IN SCIENCE

S. R. Powers
Teachers College, Columbia University, New York City

The Bureau of Educational Research in Science of Teachers College, Columbia University, working with aid of the General Education Board, is now in its sixth year. It has been concerned chiefly with in-service education of teachers. It is cooperating with selected teachers trained in science and with the schools in which these teachers are employed. The entire personnel is trying to gain, as an essential base for all its activities, a clearer understanding of some of the ways in which scientific methods and discoveries are affecting life of today. As a further feature in its work, the Bureau is studying not only the changes in ways of thinking, feeling, and acting that occur in students but also similar changes in the cooperating teachers, as these are revealed in their personal and professional activities.

Scientific scholars were enlisted as research associates to interpret some of the major problems confronting society and, thereby, to help the Bureau achieve a working understanding of life of today. They are reporting these interpretations in a manner suitable for use by the cooperating teachers and by teachers generally. The reports deal with current problems, such as maintaining a community so that its resources are conserved and, at the same time, used to further the welfare of all the people in the community; the cultural and genetic character of man and of human nature; the changes that occur in the human life span and their personal and social implications; personal and community sanitation; consumer education; and others. The scientists who have contributed include C. C. Furnas of Yale University, Paul B. Sears of Oberlin College, Duane Roller of Hunter College, New York City, H. Bentley Glass of Goucher College, F. L. Fitzpatrick of Teachers College, Columbia University, and Frank C. Jean of the Colorado State College of Education. The Bureau has also had advice and assistance from eminent scientists on the staff of Columbia University.

The Curriculum Workshop has been and continues to be one of the important agencies for advancing the cooperative studies. Experienced teachers are invited to assemble during the summer in the New York Workshop to study and plan methods of attack on common problems. These teachers use the reports prepared

by our research associates and those from other sources, and in addition they have the assistance of specialists employed as consultants in the areas under examination. The specialists who have contributed to our work include Dr. W. W. Greulich of the Brush Foundation, Dr. Halbert L. Dunn, Chief of the Division of Vital Statistics of the Bureau of the Census, J. D. Bernal of the University of London, and others.

The methods of study employed in the Workshop allow a mature consideration of contemporary problems and are not limited by pedagogical questions about methods of teaching. Through use of these methods all of us are acquiring ability to comprehend and a feeling of competence to participate in, and contribute to, the activities of a personal, community, and national life. This assurance seems to furnish a stimulation that encourages the teacher to strive to make his work more vital to the young people in his classes and to the community which he serves.

We are watching one another now to see how these studies affect our teaching. There is a staff of six persons in residence at Teachers College. Members of the resident staff will visit in each of the schools at more or less regular intervals; provision is also being made for the cooperating teachers to visit one another. Experimentation and research is in progress in each of the cooperating schools, and the cooperating teacher has assumed responsibility for initiating work and for encouraging work that is initiated by other teachers in his school or city. Working with assistance of a resident member of the Bureau the cooperating teacher will interpret the experimentation and results in a report to be addressed to the superintendent or the principal under whom he works. Suggestions of work to be undertaken usually originate from studies of the particular community and from activities already in progress in the schools.

The cooperating public schools are in Cleveland, Cincinnati, Des Moines, Detroit, Hammond, Indianapolis, New York City, Philadelphia, Trenton, and Winnetka. There are two private schools: Cranbrook near Detroit and Fieldston Ethical Culture School in New York City. In each instance the cooperating teacher is working with a reduced teaching schedule and under conditions otherwise favorable for this sort of undertaking. In several centers the teacher already has the cooperation of other science teachers and teachers of other subjects. Therefore, our cooperative program is with a school system and is carried on

through a science teacher, or, as in two of the cases, through members of the curriculum staffs who are not now teaching.

Growing out of its mature consideration of personal and community problems and out of the results of experimentation and research in teaching are a number of publications under the general title, *Suggestions for Teaching*. These include *Suggestions for Teaching Selected Material*

from the Field of Genetics
from the Field of Sex Responsiveness, Mating, and Reproduction
from the Area of the Interrelations of Living Things and Their Environment, with Particular Attention to Good Land Use
Dealing with the Use of Materials and Energy
for Assisting Young People to Achieve a Scientific View of the World
on Educational Implications of Our Knowledge Concerning Communicable Diseases.

These and other *Suggestions for Teaching*, together with the reports of the scientific men who have been employed as research associates in the Bureau, constitute its publications. They are published by the Bureau of Publications of Teachers College under the series title, "Science in Modern Living." Several volumes have been issued and more are in press. The preparation of these represents an effort to bring to curriculum committees in secondary schools a scholarly interpretation of some of the issues now under consideration in the new dynamic secondary school curriculum and also reports on methods and results employed by successful teachers in dealing with these issues.

The main objective in the work of the Bureau and its cooperating teachers is to contribute to the education of its own members and to the education of teachers generally, to the end that they may offer young people opportunity to study the problems of contemporary life and that they may help them bring to their consideration of these problems the richest resources and the best methods of work that our culture can contribute. This we believe is in step with, and in fact demanded by, the trends of the times.

The story of the progress of science is the biography of great scientists.

THE RELATIONSHIP BETWEEN SILENT READING ABILITY AND ARITHMETICAL ABILITY

ESTHER A. COFFING
Public School No. 84, Indianapolis, Indiana

INTRODUCTION

An interest in the child who has difficulty with reasoning problems in arithmetic was the motivating force behind this study which seeks to answer the following questions:

1. What is the correlation between ability in silent reading and ability to solve reasoning problems in arithmetic?
2. Is there a similarity in the correlations for the various grade levels?
3. Do the pupils who make high scores in silent reading make high scores in arithmetic?

Source of Material. The scores made by 355 pupils in grades 4B through 8A in the Paragraph Meaning and Arithmetic Reasoning tests of the New Stanford Achievement Test, Advanced Form W, were used as a basis for this study.

Method. The raw scores were used in finding the coefficient of correlation between the pupils' scores in the paragraph meaning and arithmetic reasoning tests. The correlation was found for each half grade, that is, 4B, 4A, and so on through 8A. The Pearson product-moment method was used for computing the correlations.

The raw scores in reading for each grade were arranged in rank order with each pupil's arithmetic score in an adjacent column. The mean score in arithmetic was found for each quartile division of the scores in reading.

Limitations. This study is limited to a comparison of pupils' *scores*. To find to what extent the errors in arithmetic were due to faulty reading would require an examination and analysis of the solution for each problem solved incorrectly.

The classes were uneven in size, ranging from 15 to 63 pupils.

Other Similar Studies. Investigators differ in their opinions as to whether the ability to read non-mathematical subjects comprehendingly is accompanied by ability to interpret arithmetic problems.

McCallister[1] analyzed the reading errors in several subjects,

[1] James M. McCallister, "Reading Difficulties in Studying Content Subjects," *Elementary School Journal*, XXXI (November, 1930), pp. 191–201.

including arithmetic, and found certain difficulties were peculiar to each subject, with some common to several subjects. He stated, "the reading difficulties identified by this investigation demonstrate the need for giving special attention to reading activities in connection with the teaching of each content subject."

Lessenger[2] conducted an experiment in which the pupils were given intensive training in reading. The increase in ability in reading arithmetic problems was closely related to the progress made in reading. He concluded, "The errors due to faulty reading virtually disappeared as a result of training in reading without any specific reference to arithmetic. The transfer of the

TABLE I. SCORES MADE BY 4B–8A PUPILS IN PARAGRAPH MEANING AND ARITHMETIC REASONING TESTS

Grade	4B		4A		5B		5A		6B	
Score	PM	AR	PM	AR	PM	AR	PM	AR	PM	AR
125–129										
120–124										
115–119										
110–114										
105–109					1				5	
100–104	1						2		2	2
95–99	2		1				2		2	1
90–94	2				1	1	2		8	
85–89	4			1	1	1	1	8	10	16
80–84	3		1		4	3	4	5	5	13
75–79	3	4	4	2	3	4	1	1	6	9
70–74	3	4	5	3	9	5	1		6	2
65–69	1	18	1	4	5	9	1	1	3	1
60–64		3	1	1	3	6			1	3
55–59	1	2	2	3	4	4			1	
50–54	2	4	1				1			2
45–49	4				2					
40–44	3	1			1					
35–39	3				1	1				
30–34	3	2	1			1				
25–29	4									
20–24	1	2		3						
15–19										
10–14										
5–9										
0–4	1	1								
Total	41	41	17	17	35	35	15	15	49	49

[2] W. E. Lessenger, "Reading Difficulties in Arithmetical Computation," *Journal of Educational Research*, XI (April, 1925), pp. 287–291.

improved skills from reading proper to reading in arithmetic was extensive."

In analyzing the causes of failure in ninth year algebra, Wattawa[3] states, "Recent studies show that perhaps about twenty per cent of the failures in ninth year algebra may be attributed to the inability of the students to read their problems so as to understand them. What is not so commonly recognized is that the reading of all mathematics is not only harder than the reading involved in the study of non-mathematical subjects, but perhaps requires a technique which has not been developed."

Findings

The grouped scores on which this study is based are shown in

Table I. (Continued.)

Grade	6A		7B		7A		8B		8A	
Score	PM	AR	PM	AR	PM	AR	PM	AR	PM	AR
125–129									2	
120–124										
115–119									2	
110–114			1		1		1	1	2	1
105–109	2	1	12		2	1	4	5	2	4
100–104	3		3	7	2	3	13	6	13	3
95–99	1	1	14	4	3	3	19	1	4	4
90–94	3	3	11	10	6	4	6	13	1	8
85–89	3	4	7	19	4	6	6	16	2	7
80–84	1	3	4	13	2	3	2	2	1	3
75–79	1	6	1	6	1	2	1	8	2	1
70–74	3	1	5	1		1	2	1	2	
65–69	3	3	1	2	2	1		1		1
60–64	2			1	1					1
55–59			2							
50–54										
45–49										
40–44	1		2							
35–39										
30–34		1								
25–29										
20–24	1	1								
15–19										
10–14										
5–9										
0–4										
Total	24	24	63	63	24	24	54	54	33	33

[3] Virginia Wattawa, "Reading in Mathematics," *The Mathematics Teacher*, XXVI (May, 1933), pp. 277–282.

Table I. The scores of the Stanford Achievement Test are equated in such a way that any given score has the same value for all the tests.

The coefficients of correlation between the scores in paragraph meaning and arithmetic reasoning are shown in Table II. The 5A correlation of .08 is the lowest, while the highest, a correla-

TABLE II. COEFFICIENTS OF CORRELATION BETWEEN SCORES IN PARAGRAPH MEANING AND ARITHMETIC REASONING

Grade	r	Grade	r
4B	.62	6A	.64
4A	.42	7B	.53
5B	.67	7A	.38
5A	.08	8B	.33
6B	.50	8A	.77

tion of .77 is found in the 8A grade. The 4B grade, the most elementary class to which the test was given, has a correlation of .62. The greatest difference occurs in the fifth grade, the 5B correlation being .67, and the 5A only. 08. The 6B and 6A correlations are .50 and .64 respectively, this being the narrowest range found within a whole grade.

The table of quartiles is another way of showing the relationship between the two sets of scores. The mean scores in arithmetic for the quartile divisions of the whole grades are shown in Table III.

TABLE III. MEANS OF ARITHMETIC SCORES FOR QUARTILE DIVISIONS OF GRADES 4BA–8BA

Grade	Q^4	Q^3	Q^2	Q^1	Range of Means
4BA	70.4	61.7	59.5	46.0	24.4
5BA	83.6	72.5	66.1	65.5	18.1
6BA	88.5	83.4	76.4	68.4	20.1
7BA	91.4	87.5	90.0	80.8	10.6
8BA	98.3	93.4	89.6	82.8	15.5

The greatest difference is found in the fourth grade in which the mean for the highest quartile division is 70.4, while the mean for the lowest quartile is 46.0, a difference of 24.4. A greater difference is found between the means of the highest and lowest quartile divisions in the fourth, fifth, and sixth grades than in the seventh and eighth. In every grade the means of the quar-

tiles decrease, though quite irregularly, except for the second quartile of the seventh grade, which exceeds the mean of the third quartile.

Conclusions and Recommendations

1. The fact that only one correlation is quite low, and that half of them are .50 or above indicates a considerable positive relation between the scores made in paragraph meaning and arithmetic reasoning.

2. The correlations, when viewed as a series, are quite irregular, there being no definite pattern through the different grade levels.

3. The decrease in means in the quartile divisions corroborates the conclusion drawn from the size of the correlations, and indicates that as a general thing the pupils making high scores in reading are the ones who make high scores in arithmetic.

The reasoning problems are usually the ones that are most difficult for the child who is slow in arithmetic. From experience in teaching, the writer is inclined to agree with McCallister and Wattawa who point out that a special reading technique is needed in arithmetic. However, Lessenger, whose study was largely with arithmetical computations, found that improvement in reading resulted in improvement in arithmetic. The findings of such studies should stimulate teachers to try to improve the child's reading ability as a possible aid in improving his ability in arithmetic reasoning.

MELTED SALTS CONVEY HEAT IN OIL CRACKING PROCESS

Transfer of heat by liquid is familiar to anyone who lives in a house with hot-water heating. The water is heated down in the cellar and piped to radiators where it gives up its heat to warm the room.

Many industrial processes make use of similar processes, but liquids other than water are often used, because they can be heated to a higher degree before they turn into steam. Therefore, a considerably greater amount of heat can be transferred.

A melted mixture of salts, especially the nitrates and nitrites of sodium and potassium, has been recently devised for the purpose by three du Pont chemists, W. E. Kirst, W. M. Nagle and J. B. Castner. This can be used for temperatures between 290 degrees and 1,000 degrees Fahrenheit. Below this maximum, they state, the mixture is quite stable and can be used for years, but above 1,000 degrees there is a slow decomposition.

The first extensive use of the new compound, which is known as HTS, is in the Houdry catalytic cracking process, for oil refining.

FORCES ON STRUTS DETERMINED BY ANALYSIS

EARL C. REX
Grays Harbor Junior College, Aberdeen, Washington

You can easily teach your students a powerful method, based on vector analysis, of determining the forces on struts. This method may be used to design any structures, especially those of airplanes. The author has found that students who can obtain the values of three unknowns from three simultaneous equations by determinants can quickly learn it. If, in addition, they have had a few lessons in elementary trigonometry, they can solve the most complicated of these problems.

Graphic methods are available for this type of work, but they all have at least four disadvantages:

1. They introduce errors due to drafting.
2. They are not well suited to general positions of the struts, and the forces acting on the structures.
3. They afford few opportunities for checking.
4. Drafting paraphernalia are necessary to solve by these methods.

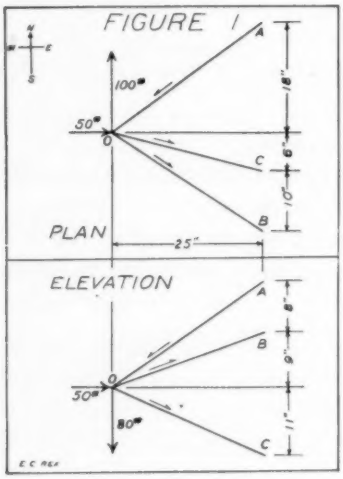
Results by the analytic method, on the other hand, can be obtained to any desired degree of accuracy by merely carrying enough decimal places. The struts and the applied forces can be in any positions. Pencil and paper only are required to get the solutions, and the available checks are adequate.

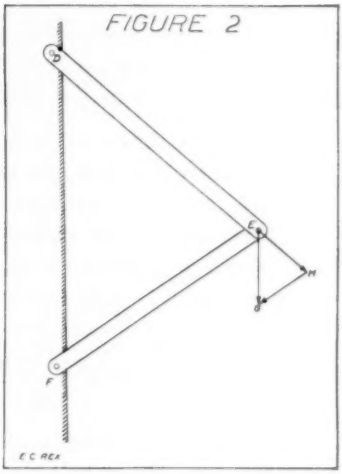
To illustrate the analytic method, consider this example (see Figure 1): Three struts OA, OB, and OC are connected at O, and subjected to three known forces at that point. A 50 pound force is acting eastward, a 100 pound force is acting northward, and an 80 pound force is acting downward. Directions of the strut reactions are assumed to have the directions shown by the half-arrows. This assumption is based on the primary assumption that the system is pin connected. That is, the struts are joined together and are fastened to their supports by pins or hinges (see Figure 2). When the action lines of all forces meet at a common point, such as O in Figure 1 or E in Figure 2, no appreciable error is introduced by this primary assumption.

In a pin connected system, however, the component of the load borne by each strut is in the direction of the strut. The component EH in Figure 2, for example, is the only one sustained

by strut *DE*, since component *HG* merely tends to rotate strut *DE* about *D*. Component *HG* is, on the other hand, borne by strut *EF*.

The rectangular components of the load on *AO*, Figure 1, would therefore be in the same ratio as the components of the direction of *AO*. The order of the letters naming the struts also denote the sense of the assumed reactions. *AO*, for instance, means "in the sense from *A* to *O*." If any or all of these senses have been assumed wrong, the answer or answers will be negative, as is shown later.





In the vector notation, east and west are the i directions; east is positive, west is negative. North and south are the j directions; north is positive, south is negative. Up and down are the k directions; upward is positive, downward is negative. Deviations from these rules may, of course, be made to fit any problem. Upward, for example, may be made the negative direction, and downward the positive; we do not have to have a right-handed system, because we do no vector multiplying in this type of problem.

Noting the dimensions in Figure 1 we therefore find:

$$AO = m(-25i - 18j - 17k)$$
$$OB = n(\ 25i - 16j + 9k)$$
$$OC = p(\ 25i - 6j - 11k)$$

where m n, and p are to be determined. Also, the resultant of the known forces is:

$$F=50i+100j-80k.$$

All these forces (AO, OB, OC, and F) must add to zero, because the system is in equilibrium, therefore:

$$AO+OB+OC+F=0,$$

that is:

$$(-25m+25n+25p+50)i+(-18m-16n-6p+100)j \\ +(-17m+9n-11p-80)k=0.$$

From the first condition of equilibrium (which can be easily explained to students who have not had physics),

$$-25m+25n+25p+50=0$$
$$-18m-16n-6p+100=0$$
$$-17m+9n-11p-80=0$$

These give the three simplified simultaneous equations

$$\left.\begin{aligned} m-n-p&=2\\ 9m+8n+3p&=50\\ 17m-9n+11p&=-80 \end{aligned}\right\}\ldots\ldots\ldots\ldots A.$$

Solving by determinants, $m=83/38$, $n=566/95$, and $p=1097/190$. Then the numerical value of the force on strut AO is, by the Pythagorean theorem:

$$83/38\sqrt{(25^2+18^2+17^2)}=83/38\times 35.18=76.84 \text{ lb.}$$

Similarly, the force on OB is found to be 185.81 lb. On OC the force is -161.45 lb.

It was at first assumed that strut OC was under tension (reaction to the right in Figure 1). The negative sign for the force on this strut shows that this assumption was wrong. Therefore:

AO has a 76.84 lb. compressive force.
OB has a 185.81 lb. tensile force.
CO has a 161.45 lb. compressive force.

The usual checks for simultaneous equations can be employed. If the given forces are not at right angles to each other, they can be resolved into two or three that are, or the resultant of the forces can be found by simple trigonometry. In actual practice the work would begin with equations A.

EFFUSION APPARATUS FOR DEMONSTRATION OF GRAHAM'S LAW

C. R. JOHNSON
University of Texas, Austin, Texas

J. P. FINFROCK
San Jacinto High School, Houston, Texas

To those of us who teach chemistry or physics, the truth expressed in Graham's law becomes commonplace, and in introducing the law we are apt merely to state it, or at most to demonstrate it qualitatively. This seems unfortunate, since the presentation of Graham's law offers an opportunity for a good quantitative demonstration experiment. It is also possible to use the experiment as an illustration of the occasional practical importance of applying vapor pressure corrections in scientific or engineering problems involving gases.

Perhaps the main reason for the tendency to use qualitative rather than quantitative experiments in illustrating Graham's law is the scarcity of suitable quantitative effusion apparatus listed in scientific supply catalogs. The standard Schilling apparatus is found in most catalogs, but the price of this is prohibitive for high school use, and in any case it is not intended for demonstration purposes.

For the reasons indicated above, we have designed an apparatus which may be used for the rapid collection of effusion data so that all operations may be seen by a large class. This apparatus is shown in the figure. Made with a heavy stopcock having a three-millimeter bore (Pyrex No. 7380) one of these was purchased for $5.75, complete with the 0.35 mm. capillary seal and colored markings. Another with a stopcock of smaller bore was made from stock Pyrex items purchased for $3.00, but an oxygen blast burner was needed for the glassblowing work.

To make an effusion measurement the apparatus is filled with the gas to the lower mark, while immersed in water in an hydrometer jar. The size illustrated requires an 85 mm. $\times$ 500 mm. jar. With a definite initial head of water as a driving force, the stopcock is opened and the time required for the water level to rise to the upper mark is measured. Complete demonstration data may be collected in a few minutes if tank gases are available, but the experiment does not take much longer or become

any less interesting when gas generators are used.

We have made a number of measments with an effusion apparatus having the dimensions given in the figure, to determine its characteristics. The measurements were made at 30°C. with an initial head of 430 mm. of water and a final head of 60 mm. From these water levels and the barometric pressure the average pressure of the gases during effusion was calculated graphically as equivalent to 767 mm of mercury reduced to 0°C. The measured effusion times for any one gas covered a range of a second or two, which is close enough for a demonstration experiment, but it may be noted that a value correct to within a few tenths of a second may be found by making several measurements and taking the median. In the following table T is the median time of effusion in seconds, derived from five to ten measurements for each gas. D is the density of the dry gas in grams per liter at 30°C., 767 mm., calculated by the general gas law from the density at standard conditions, as given in the International Critical Tables. D' is the density of the moist gas under the same conditions, calculated from the relation

$$D' = \frac{273}{760 \times 22.4}\left[\frac{M(p-a)+18.0a}{273+t}\right] \quad (1)$$

in which p is the average pressure of the moist gas during effusion, M its molecular weight, and a the aqueous tension at t°C., the temperature of the system. The two pressures are in millimeters of mercury reduced to 0°C.

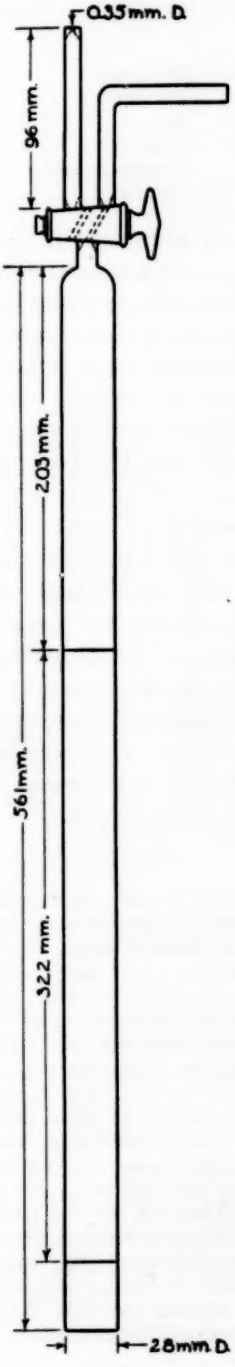


TABLE I. EFFUSION OF GASES

Gas	D	D'	$\sqrt{D'}$	T	$\sqrt{D'}/T$
Hydrogen	0.082	0.109	0.33	13.8	0.024
Methane	0.65	0.65	0.81	33.6	0.024
Air	1.18	1.16	1.08	43.5	0.025
Oxygen	1.30	1.28	1.13	45.4	0.025
Carbon dioxide	1.80	1.74	1.32	50.9	0.026
Chlorine	2.92	2.79	1.67	62.2	0.027

It is evident that hydrogen should not be used as one of the gases in a quantitative demonstration of Graham's law unless a correction is made for the vapor pressure of water. This correction is a little complicated and can be avoided by using for demonstration purposes only gases for which D and D' are essentially equal. However, most students taking elementary chemistry or physics should have a good background of algebra, and some teachers might prefer to give their students an opportunity to apply it in this connection, say, in finding out why (moist) hydrogen does not appear to obey Graham's law, while air and carbon dioxide do.

The apparatus shown in the figure may also be used as an effusiometer for measuring unknown gas densities. For this purpose, D' is calculated from T by the relation $D' = (kT)^2$, or perhaps better found by a comparison with some known gas of about the same density, under the same conditions of temperature and pressure. The molecular weight may then be calculated from D' and the experimental conditions, after solving equation (1) for M.

NEW PROCESS TURNS HARDWOOD INTO PLASTIC

Wood can be converted into an easily bent and molded plastic by a new process developed at the U. S. Forest Products Laboratory. Worked into any desired shape while hot, the plasticized wood becomes as stiff and strong as ever upon cooling.

The new treatment is a by-product of the Laboratory's research on the chemical seasoning of refractory woods. During the experiments it was found that oak, soaked in a concentrated solution of urea and then dried, became plastic when heated to about the poiling point of water, though the wood was still dry. It remained plastic while hot, and resumed its normal "woodenness" upon cooling.

Sawdust and chips, similarly treated, can be heated and pressed into any desired shape. This material is self-bonding, that is, it sticks together without the addition of any outside adhesive.

Thus far, the new process has been used principally on hardwoods, particularly several species of aok. However, preliminary experiments indicate that softwoods like juniper and Sitka spruce will also give good results under the same treatment.

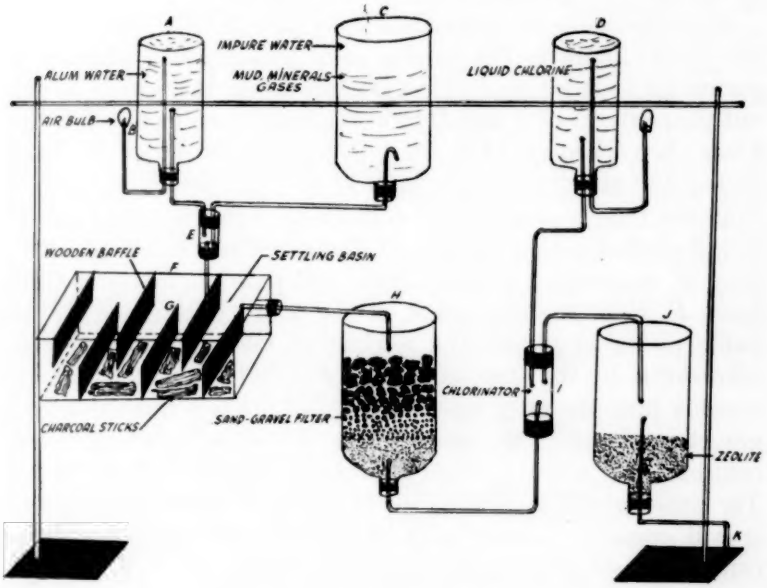
Patents covering the new process have been applied for by the Forest Products Laboratory.

A MODEL WATER PURIFICATION SYSTEM

HUBERT J. DAVIS
Matthew Whaley High School, Williamsburg, Virginia

Since the subject of water purification is taken up in all of the science classes from the seventh through the twelfth grade, a model water purification plant will be found a helpful teaching device for all of these grades. The model plant described here is designed to show the principles involved in removing suspended, dissolved, as well as hardening impurities and objectionable odors.

Very little expensive equipment is needed. If the model is to



be set up for permanent use it would be better to have a group of pupils build a wooden framework to support it instead of using the ringstands and clamps as here suggested. The removal of the bottoms of the jugs, assembling the model, bending the glass tubing, etc., offers the high school pupil a real challenge.

The apparatus needed is two tall ringstands, five iron clamps, four large rings, three small rings, three one-half gallon jugs, one five-quart tin motor oil can, two one-half pint round bottles, two pint round bottles, two medicine dropper bulbs to fit the glass tubing used, rubber stoppers, glass tubing.

The chemicals needed are 500 grams of pure alum, ten char-

coal sticks, 50–100 cc. of liquid chlorine or concentrated chlorine solution, 1000 grams of permutit or zeolite, five pounds of fine sand, and an equal amount of coarse sand and gravels.

Cut the bottoms from the three large jugs to use for bell jars *C*, *H*, and *J*. Remove the bottoms and the necks from the two smaller bottles and use the resulting glass cylinders for *E* and *I*. Cut the side from the oil can and use it for the settling basin *F*. Install wooden baffle plates as shown in the diagram.

Bend the outlet tube from *C* into an inverted *U* and draw it into a point so that the flow of the impure water may be regulated to agree with the flow through the filter, and the inverted *U* will prevent clogging from settling particles.

Draw the air-inlet tubes used in *A* and *D* to a point and fit the rubber bulbs to the outside ends. Punch small pinholes to permit air to enter, and adjust the size of the holes so as to permit the contents of *A* and *D* to be removed in eight to ten hours. Place the carbon sticks in the settling basin *F* under the baffle plates. Put the filtering layers in *H* and put the zeolite into *J*. Pour the muddy, hard water containing dissolved gases into *C*. It will gradually drip through to *E* where it will be mixed with a drop of concentrated alum water and pass on to the settling basin *F*. Here the movement of the water is retarded by the baffle plates to permit the settling of the mud, and the deodorization by the charcoal. When *F* is full the water will drip steadily into the filter where it will be filtered through coarse gravel, and sand. By gravity the water will flow into the chlorinator *I*, where a small amount of chlorine will be added. The pressure will soon force the chlorinated water into *J* where it will come in contact with the zeolite and be softened. It can be drained off as clear, pure, soft water at *K*.

When properly adjusted this should carry one gallon of water through per hour. This apparatus involves all of the principles of the city water purification system.

SULPHUR vs. SILVER

The enormous range in electrical conductivity of the elements is not generally appreciated. The ratio of the conductivity of sulphur to that of silver is as 1 to 10^{21}. K. K. Darrow once pointed out that a disc of sulphur .02 mm. thick offers more resistance to an electric current than a silver conductor of the same diameter extending from *Alpha-Centauri* to the earth.

THE USE OF THE ROTARY SYSTEM IN TEACHING BIOLOGY*

E. D. COLLINGS
John Marshall High School, Cleveland, Ohio

For the past five years there has been an experimental procedure in the teaching of Biology at John Marshall High School. The experiment was developed by the late R. G. Jones, former Superintendent of the Cleveland schools. Several schools in the Cleveland System still use this method in certain History and Science classes. The procedure has been called the Rotary System, since the teacher activity *rotates* with the pupil activity.

When the Science Curriculum Center was established in the fall of 1939, with Mr. Arthur O. Baker, head of the Science Department of John Marshall High School as chairman, it was decided to keep the Rotary System in Biology as a definite part of the experimental procedures. The large lecture groups of the Rotary System offered an unusual opportunity for experiments in subject matter and technique, especially with emphasis upon visual aids, debates, recordings, and other departures. Whatever a section or group had to offer, there was afforded an opportunity for the entire combined groups to see, hear, or participate in, as an assembled unit during one of the large lecture periods. No other possibility of ordinary class set-up offered so much for group experimentation.

Under this system, the pupil's program calls for five periods per week, as in the ordinary set-up. However, the big difference is that in three of his periods he meets with a very large lecture group. At this time, he has a prepared lecture with demonstrations, or receives visual instruction by means of sound films, silent films, or lantern slides. Usually two of his lecture periods are devoted to this procedure, the last lecture period of the week being devoted to assignment and tests. His two other periods of class attendance may fall on some different period of the school day, and he finds himself in a small section of about 25 each. The first meeting each week in this small conference group is known as a Reading Conference, at which time guided reading is pursued. His second conference is one of discussion, where his small group is further split up into groups of five each, with a group leader in charge to receive his written assignments for

* Read before the Biology Section of the Central Association of Science and Mathematics Teachers, Cleveland, Nov. 22, 1940.

the week, and to conduct the small group discussion for about half the period, when the instructor calls the entire group in to a general discussion.

If a teacher has six periods, or 30 teaching periods per week under the ordinary set-up, he would find himself teaching 24 periods per week under the Rotary System. This amounts to six less periods per week, or the reduction of one full day's teaching time. The teaching time saved by the instructor may be used to prepare future lessons, check tests, or assemble materials for future demonstrations.

A question naturally arises in the minds of those who use the ordinary set-up in biology. They ask: "What are you trying to achieve in this Rotary System? What can you do that cannot be achieved in other classes?" Therefore, we state the classroom goals under the Rotary System:

1. Visual demonstrations delivered to large groups at a maximum of efficiency on the part of the instructor.
2. The use in large groups, of lantern slides, silent and sound films, exhibit and demonstration material, and the public address system. Thus all pupils see and hear effectively.
3. The preparation of clarified assignments, and modern tests.
4. The preparation of such correlated work sheets, based upon the visual aids used, that lantern slides and films become agents of instruction demanding the attention of the pupil. Visual aids therefore, do not become pure entertainment.
5. Discussions in groups of such a small size that all members participate.
6. The development of leaders and leadership by placing pupils in charge of small groups for certain activities.
7. The establishment of teacher-pupil contact.
8. The inclusion of a reasonable amount of guided study.
9. The securing of such individual pupil activities as the performing of experiments and conducting projects.

If a school desired to try out the Rotary System of instruction in science, the questions which come to mind are those dealing with expense and necessary equipment. We can say that the necessary equipment to carry on the Rotary System calls for:

1. A large room in which visual aids can be used in connection with the demonstrations. This room should be equipped

with projection screen, dark shades, and a public address system. The P. A. system enables all pupils to hear effectively.

2. Small laboratories and conference rooms.
3. Cellophane lantern slides to substitute for the many diagrams and sketches used on the classroom blackboard. These enable all pupils to see effectively. The room should be in semi-darkness, thereby permitting note taking.
4. Apparatus wagon with ball-bearing wheels to transfer apparatus and equipment with dispatch.
5. An illuminated portable blackboard.

Sample Schedules

THE FORMER SCHEDULE OF A TEACHER TEACHING SIX CLASSES PER DAY OF TENTH GRADE BIOLOGY

Teacher's Daily Load = 210 pupils
(Class average of 35 × 6 Periods)

	1	2	3	4	5	6	7	8	9
M		35-B	35-B	35-B		35-B	35-A	35-A	
T		35-B	35-B	35-B		35-B	35-A	35-A	
W		35-B	35-B	35-B		35-B	35-A	35-A	
Th		35-B	35-B	35-B		35-B	35-A	35-A	
F		35-B	35-B	35-B		35-B	35-A	35-A	

Key
B = 10th Grade Beginners in Biology
A = 10th Grade Advanced to Second Semester in Biology

THE SAME TEACHER'S SCHEDULE UNDER THE JONES ROTARY SYSTEM OF INSTRUCTION

Teacher's Daily Load = 210 pupils

	1	2	3	4	5	6	7	8	9
M	25-A	140-B	25-A	20-A	Teacher prepares				
T	70-A	25-B	25-B	25-B	25-B		20-B	20-B	
W	25-A	140-B	25-A	20-A	Teacher prepares				
Th	70-A	25-B	25-B	25-B	25-B		20-B	20-B	
F	70-A	140-B	Checking of tests and preparation for next week						

A PUPIL'S SCHEDULE WHO REPORTS FOR 2ND PERIOD VISUAL DEMONSTRATION AND 7TH PERIOD CONFERENCE

	1	2	3	4	5	6	7	8	9
M		Visual Demon.							
T							Guided Reading		
W		Visual Demon.							
Th							Confer-ence*		
F		Assign-ment and Test							

* Conference period may be spent in several ways depending upon the judgment of the teacher:

1. Laboratory exercises
2. Discussion period for the group of 20 to 25 pupils
3. Drill exercises
4. Conference group of 25 pupils may be broken up into 5 small groups with 5 pupils in each. Group leaders may be selected by the teacher and one may be placed over each group to:
   a. Review of assignment
   b. Conduct a project or experiment
   c. Hear oral reports
   d. Conduct review drills
   e. Conduct a discussion

The teacher may confer individually at this time with pupils who are failing in their work.

When it is agreed that the Rotary System may save the teacher from monotony of repeated subject matter and technique, the question still to be considered is whether this System has any advantages to offer through the small conference groups. Briefly, the advantages may be summed up as:

1. The teacher is assured that in the course of a week each pupil has personally read a minimum of one period in preparing the assignment.
2. Fewer pieces of apparatus required because of the small size of the group.
3. Experiments can be performed more individually.
4. All members of the group of 5 can take part in the discussion because of the small size of the group.
5. Pupils may examine the demonstration material closely which was used during the lecture periods.

In our school we have noted a very definite interest of the pupils who have been assigned to the Rotary System. This se-

mester 37 pupils asked to have programs changed, after the first week of school, so they might include biology in their courses. The Rotary System is largely responsible for this move. Pupils do recognize its uniqueness and are willing to try out its method. The advantages of the Rotary System come to pupil and teacher alike. In conclusion we may say that the advantages of the Rotary System are:

1. Teaching periods may be cut from 30 to 24 per week.
2. Teacher has more time to prepare his work.
3. Monotony is avoided.
4. Visual instruction used effectively.

NEW ELECTRIC LAMP USES TELLURIUM

Tellurium, an element related to sulfur, discovered about a century and a half ago, and, though not rare, has so far found very few applications, is used in a new electric lamp. To its inventors, John W. Marden, East Orange, N. J., Norman C. Beese, Vernona, N. J., and George Meister, Newark, N. J., the U. S. Patent Office has granted U. S. Patent 2,215,648. Rights have been assigned to the Westinghouse Electric and Manufacturing Company. The inventors are connected with the Westinghouse Lamp Works, at Bloomfield, N. J.

Actual light comes from a glass tube shaped like an inverted J, contained in a larger bulb. The tube contains tellurium vapor. With a tube four inches long and a little more than a half inch in diameter, satisfactory operation was secured with two to three amperes of electrical current at 150 to 200 volts.

A curious characteristic of the tellurium light is that it resembles that of a glowing solid more than of a glowing gas. The latter usually, when broken into a spectrum, shows a series of bright lines, but that from tellurium vapor shows more of a continuous spectrum. When operated at the correct voltage, its light is very close to daylight, so perhaps the lamp will have applications where artificial daylight is needed.

HAND APPLIANCES CHECK MOST FIRES

Fifty to ninety per cent of all fires occurring in industry are extinguished with hand fire appliances, without calling for fire department aid, says Herbert W. Lange, assistant engineer of the Underwriters' Laboratory at Chicago. At least fifteen per cent of the fires upon which an alarm has been sounded are likewise put out by the time the department arrives, he states.

Proper use of the extinguished is essential for its effective use, however. In class A fires, those involving wood, paper, textiles and the like, "The extinguisher stream should be applied in a systematic manner," he urged. "On vertical fires, attack should be directed at the bottom and progress made upward only after bottom areas have been definitely extinguished. Otherwise, reflashes will soon reach original intensity with portions of the extinguisher discharge wasted."

PLANNED FIELD TRIPS—AN INTEGRAL PART OF SCIENCE UNITS*

DORA WOOD
Hayes School, Lakewood, Ohio

First of all I want to explain that I do not consider myself an authority on field trips—far from it. In the past few years we in Lakewood have been working on some trips which we feel have added a great deal to the units of work of which they are a part. Today I want to explain some of the methods which we have found useful in the hope that they may prove useful to you, or at least may stimulate your thinking along the same lines.

You have often said, "Seeing is believing"; and if you really mean what you've been saying, then you believe in field trips. For after all, field trips are an ideal form of the visual education that we have been hearing so much about these days. Today, in most systems they are not considered extra-curricular, but are an essential part of the school program. And rightly so, for they help put meaning into words.

Learning, in the past, was considered a "pouring-in process" in which the child was a passive learner. Not so today. Why read about beech-maple forests, generators, weather stations, or sedimentary rock, when you can go a short distance from school and see these things? The out-of-doors is the perfect text book for a teacher of nature study. It is the real thing in which the children are interested. Why have a second-hand imitation when you can get the genuine article? Of course, you'll want to do some reading, too, but it's the field trips that vitalize the subject, that make the ideas concrete, that arouse a spirit of inquiry such as you will never get from books alone.

To be successful, each trip must have a definite purpose growing out of the school work. A field trip should never be chosen at random because it might have value or it might be interesting. It must be an integral part of work done in the classroom. It might be used to introduce a unit of work, or perhaps as the culminating activity of that unit. Sometimes a trip is taken for the purpose of gathering information to help in solving a problem or in developing a major understanding.

The first requisite for doing any job well is knowing that it is

* Read before the Elementary Science Section of the Central Association of Science and Mathematics Teachers, Cleveland, Nov. 22, 1940.

worthwhile. Before a trip can be successful, the teacher must have ultimate faith in its value. She must be "sold" on the idea—willing to take time and energy in preparing for the trip.

Any trip necessitates preparation comparable to that done for a very difficult lesson. A successful outcome depends on careful planning and organization. Nothing must be left to chance. The teacher must know what is available and where it is without having to hunt for it. Some trips have aroused criticism in the past, due to the fact that they were not well planned.

Where do we go on our field trips? The answer to this question would depend upon the subject being studied. To be successful the trip does not need to be miles away from school. A very worthwhile one might be taken to the basement of your school building to study the heating or ventilating system of the building. You might go out to the school yard to study various types of trees; or you might walk to a vacant lot nearby to study seed dispersal or to find some evidences of erosion. These are field trips just as surely as those in which you cover a great distance.

The teacher must first go over the ground to be covered a number of times so that she knows its possibilities. She gathers all the information she can from reading widely and from personal contacts with people in the neighborhood in which the trip is to be taken, or with various authorities on the subject. In numerous ways she gets all the background material possible. Then, keeping her objectives in mind, she begins limiting the material. This is a very important step. We have found from experience that, in our eagerness to get many ideas across, we may very easily attempt too much on one trip.

In the work done in Lakewood in the last few years we have found the idea of using guide sheets to be very effective. The teacher prepares a guide sheet for each child, listing in some way the items which she wants the child to be sure to observe. This guide sheet must not contain too much reading material, for we must keep in mind the fact that the child is on the trip, not to spend the time looking at a guide sheet, but to make actual observations in the field. The guide sheet, then, is merely a means which we have found useful in guiding the child's observations.

What else should the teacher do in preparing for a field trip? We can save ourselves much trouble by sending a note home to the parent stating where and when the trip will take place and getting the parent's written permission. In our school we re-

quire a note from each pupil before we permit him to go on a trip.

The type of transportation used will depend upon the place to which you are planning to go and the financial condition of the families in your community. On some trips it will be possible to walk. On other trips parents may be asked to take the children in cars. Street cars have an advantage because of the low cost, but going by bus seems to be the ideal method of transportation. Street cars and buses are usually protected by insurance and, therefore, do not involve the risk that private automobile transportation does.

Before we go on the trip we should try to create an interest on the part of everyone who goes. Children who are not interested often become nuisances. When discipline problems arise they are usually caused by lack of interest on the part of the child or lack of organization on the part of the teacher. It is a good idea to let the class set up standards of conduct for the trip. When children make their own standards they are more likely to live up to them than if the standards are imposed upon them by the teacher.

In the introductory lessons it is necessary to get across the ideas and concepts that you will not have time to explain on the trip. Still pictures are a very great asset to use, perhaps showing some of the things they are to observe. On the other hand, we must not give so much information that we kill the interest and rob the child of the joy of discovering for himself. It seems better to use most of the informational material after the trip.

At Hayes we have found it worthwhile to go over the guide sheet with the children the day or morning before the trip to be sure that the vocabulary is familiar and to give the child an idea of the things for which he will be looking. Certain questions are often raised in advance with individuals or groups made responsible for finding the answers. Then too, it is a good idea to attach the guide sheet to a piece of cardboard and fasten a pencil by a string to the sheet. This makes it possible for the child to write on the sheet at any time during the trip.

On the day of the excursion be sure that the children come prepared. If the trip is outdoors they should be dressed for the out-of-doors. The materials to be taken in addition to the guide sheet will again depend upon the type of trip. Perhaps some of the children have cameras to take along. It is a good

idea to bring back illustrative material for future use. If you are going where you may collect things, paper bags and bottles are handy articles to have.

On the trip we must remember that the children are the doers, but they must be directed in what to observe. If you are in a bus it is possible to give directions before they get out of the bus. With a large group, the job of guiding the child's observations is more difficult. It is sometimes possible to divide the class into smaller groups. Then show one group and have them distribute themselves among the various other groups as guides. Or it might be better to take one group on the trip before-hand and prepare them as leaders for the others.

It should be remembered that the guide sheet is not, in any sense, a test. The children should understand that they may confer with each other and get help from one another. It is for them to use and is not to be collected and graded at the end of the trip. All unanswered questions may be recorded on the sheet for further study.

If we have no follow-up the trip loses its point. It becomes merely a matter of getting out of school rather than a very vital class lesson. Reading follows the trip. Books now become tools for adding to the ideas gained at first hand. Here is our chance to go over the guide sheets, not to correct them, but to have a general discussion of questions and problems and to check on any mistaken concepts. Now it is necessary to draw from the trip the outstanding factors and to fit them into the unit being studied. It is possible to use the same slides and pictures that you used before the trip. You will be surprised at the things the children will see now that they did not notice before. Perhaps you can add other slides and pictures, some which you might get from the state department or from educational museums in your neighborhood. Perhaps you will want to include group reports, paragraph writing, or letter writing to gain added information. Here is your chance for art, reading, and language correlation in a real, live situation.

After this follow-up some teachers find that a repeat trip is valuable. The class may go together or the children may go in groups on their own or with their parents.

Satisfaction should be felt by the children, not only for getting information, but also for achieving standards set up for conduct. Include a discussion in which the class may evaluate the experience.

I have outlined for you the general procedure which we have found helpful in preparing for trips, in taking the actual trips, and in following up after them. Now I would like to show you how this procedure worked in the trip which we took as a part of our study of the unit, "Rocks Tell the Story of the Earth's History."

Since Rocky River Valley, a part of the Metropolitan Park System of Cleveland which is near our school district, has a fine exposure of sedimentary rocks and an interesting geological history, we chose this region for the trip.

What were some of the ideas that we could get across better by a trip of this sort than by reading them from a book? This was the next question to be considered. Our list included the following major understandings:

1. The earth's surface is constantly changing.
2. Processes taking place millions of years ago are taking place today.
3. The rocks of a region help to explain the geological history of the region.
4. Fossils tell the story of early life on the earth.

Then, where in the valley would be the best places to stop to gain these concepts? As we answered these questions we began to plan the itinerary. It took two or three trips to the valley on week ends and after school to get the questions answered.

We knew that the Trailside Museum contained an exhibit of fossils and a papier-mâché map of the valley. This, then, seemed the logical first stop. Here the children could get a complete picture of the area they were to cover.

Then we listed all the material which the children might observe that was directly related to our major understandings. Next came the job of sorting out. Non-essentials were crossed off. From what was left we worked out the pupil guide sheet. We tried carefully to arrange the material so that the child would have a minimum amount of writing to do, leaving him a maximum amount of time for observing.

The transportation problem was our next consideration. Since we have a bus available at a reasonable rate and our children, in the main, can afford this expense, we decided to use the bus. We divided the cost among those going on the trip.

Because the excursion was used to develop certain understandings about the earth's history, it was necessary to decide

what minimum amount of material the pupils would need to know before taking the trip. Since we were to find sedimentary rock, see evidences of erosion, and look at a pre-glacial river valley, these terms needed discussing and explaining. Now was our chance to show pictures previously taken to help explain the terms.

Could the class set up some standards of conduct for the trip?

A TRIP TO ROCKY RIVER METROPOLITAN PARK TO STUDY ROCK LAYERS
DORA WOOD, HAYES ELEMENTARY SCHOOL - LAKEWOOD, OHIO

Pupils' Guide Sheet

I. At the Trailside Museum

Examine the relief map.
The blue represents ..... shale.
The red represents ..... shale.
The yellow represents the valley of the pre-glacial Rocky River. This valley was filled in by the glacier.
Notice the fossils:
..... trilobites ..... brachipods
..... sharks ..... plants

II. At Little Cedar Point

Find the two branches of the river.
Notice where they come together.
Observe how the point is being worn away.
Find:
..... sandstone ..... granite
..... Cleveland shale

III. At the site of the pre-glacial river valley

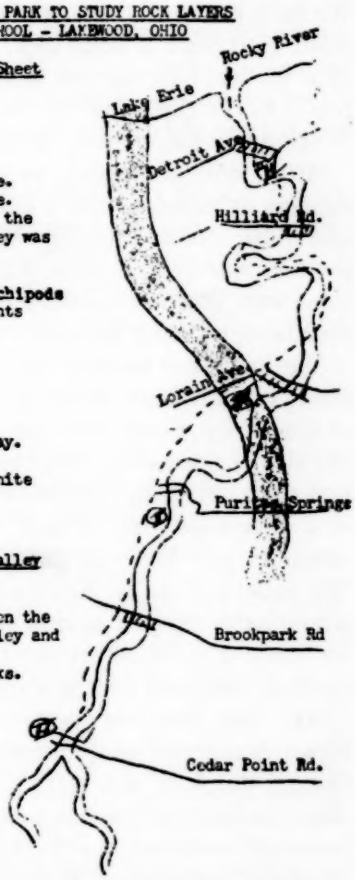
Notice how wide the valley is.
Observe the different appearance between the shale wall in other parts of the valley and the glacial till here.
Find flat-sided, glacier-scratched rocks.

IV. At the north end of the valley

Observe and collect samples of Chagrin shale.
Notice the Chagrin shale is under the Cleveland shale. The ....., then, must be older.
Break up some of the Chagrin shale in the water. It becomes clay.

Check the evidence you have seen which would support the idea that this whole area was once under water.

..... fossils
..... straight layers of rock
..... sedimentary rock



Roman numerals show bus stops.
Bridge across the river
Bridge across the valley
Our route
Old river valley now filled with glacial till

After much discussion and revision, the following rules were agreed upon:

1. We must be courteous.
   a. We must listen to our guide.
   b. We must try to keep our voices low when we are on the bus.
2. We must keep with the group.

The day before the trip we had to prepare our guide sheet. We took the cardboard from our manila tablet and fastened the sheet to it with a large clip. Our school keeps a supply of the clips on hand for use on field trips. We took string and tied a pencil to the clip. Now we could read over the material carefully to see just what we were to observe.

After more discussion we decided it would be wise to wear rubbers or galoshes and warm clothes, since it was early spring and quite cool and muddy. We agreed that it would not be wise to wear our best clothes. Cameras and paper bags for collections were listed as valuable items to take along. The class chose four boys to bring hammers to break open some of the rocks.

We had local showers the night before the trip but the sun shone bravely that morning. The bus took us first along the rim of the valley. From there we could look down and get an idea of the size of the valley, observe its flood plain, and remark on the fact that a river the size of this one could carve a valley so large in a once-level area of land. Then we headed for the Trailside Museum and followed the route indicated on the guide sheet. We collected rocks, hammered rocks, and took pictures. We would have enjoyed having more time to spend on this trip, but we made a point of getting back to the school at 12 o'clock as we had indicated on the Parent's Consent Blank.

The next day we went over the guide sheet checking our ideas. A number of questions had been raised. Did the glacier change much of the earth's surface? How and why is granite different from sedimentary rock? Are there other kinds of sedimentary rocks besides the kind which we have found? Broken up shale makes clay. When crumbled, what do other kinds of rock make? From what are rocks made? Two fossils were found. Are there many fossils in this shale? How do we know when the glacier covered this area? These and other questions were recorded on the board. They furnished a basis for many days of further study.

Reading, written language, and many discussions followed.

Letters were written to the Natural History Museum asking for information.

We needed to identify our rocks. We used adhesive tape to attach labels. Some of the children made rock collections, and they are still adding them. These varied from collections placed in simple egg boxes to those packed with cotton batting and placed in large, specially-built (though not too well constructed) boxes. We held a *Rock Day* on which all the collections were brought to school.

The children became fascinated by the large dinosaurs about which they read. They decided to make clay models. Then to show them off to better advantage a sand table was covered with green paper and large pre-historic trees were made so that the dinosaurs would look "at home."

We showed a film entitled "The Earth's Rocky Crust" and we displayed pictures taken on our trip. Opportunities for class planning and class discussions seemed limitless. We foraged through the school library for books. We wrote our own story of life in these pre-historic times. Throughout the whole unit the interest did not seem to lag.

UREA FOUND USEFUL IN CATTLE RATION; MAY MEAN FUTURE SAVINGS

Urea, a simple nitrogen compound hitherto used principally in fertilizers and plastics, can be mixed with cattle feed as a substitute for more expensive sources of nitrogen, nutrition researches at the University of Wisconsin indicate.

Comparative feeding experiments, conducted by I. W. Rupel, G. Bohstedt, M. I. Wegner and E. B. Hart, showed that groups of cows receiving urea as their principal source of nitrogen produced as much milk as similar groups which got their nitrogen in the form of the considerably costlier linseed oil meal.

The experiments lend support to the theory that bacteria in the digestive tract of cattle assist in their nutritional processes. When natural stomach juices from the animals were mixed with urea and cattle feed, under proper chemical and physical controls, as much as 95% of the urea disappeared, to reappear in the structure of bacterial cells. Furthermore, when some of the contents were withdrawn from the stomach of a living heifer, after feeding, it was found that all the urea had been converted into ammonia within an hour, and in four or five hours the ammonia had disappeared, presumably going into the bodies of bacteria as protein.

Further experiments on the feeding value of urea are now in progress.

THE PLIGHT OF HIGH SCHOOL PHYSICS

*VI. Unit Trouble**

H. EMMETT BROWN

Teacher of Science, Lincoln School, Teachers College, and Instructor in Teaching of Natural Sciences, Teachers College, Columbia University

The number and complexity of the units in which the high school student of physics is asked to measure the various physical quantities with which he comes in contact is truly large. The student in chemistry has his own technical problem in learning to balance equations, to read formulas, and the like. But he has a simple task as far as coming to understand the units in which quantities are measured. A few units of weight and volume, heat units, the notion of specific gravity, Centigrade and Fahrenheit thermometer scales and, in the main, he is done. The physics student, on the other hand, needs to understand not only these but also such other units as those in which we measure work, power, velocity, electrical current, and a host of other quantities. We might, of course, reduce the number of units, by reducing the number of different kinds of things which the student needs to measure—a procedure which is worthy of consideration. That, however, is a task for curriculum reconstruction. The present article confines itself to the more specific and simpler problem of what may be done to reduce the difficulty and confusion that inheres in our present use of units.

One inescapable kind of difficulty arises from the simple fact that many of our units are compound ones. They are made up of two or more basic units. Units such as the *foot-pound* and the *gram-centimeter* are unique in character. The thing which they measure cannot be directly experienced like a force, nor seen like a length. The very appearance of the words may add to the difficulty of their understanding. Thus, while *blue-eyed* does refer to a special kind of eye, and *air-cooled* to a special method of cooling, the *foot-pound* is most decidedly not a special kind of *pound*, nor the *gram-centimeter* an unusual sort of *centimeter*, the *gram*-centimeter. They are units which are fundamentally different from the basic units of which their names are composed.

* Other articles in this series have appeared in SCHOOL SCIENCE AND MATHEMATICS as follows: Introduction. June, 1939. (39: 558–61; 1939); I. "Water-Tight Compartments." Dec. 1939 (39: 840–5; 1939); II. "Peccant Psychology." Feb. 1940 (40: 156–60; 1940); III. "Mismanaged Mathematics." Apr. 1940 (40: 368–76; 1940); IV. "The Languishing Laboratory" May, 1940 (40: 457–62; 1940); V. "Social Implications." Dec. 1940 (40: 815–23; 1940).

They measure a new kind of thing altogether, not simply a special kind of distance, nor an unusual force.

But these units can be made understandable, functional. Students beginning the study of physics either already have, or can easily arrive at a clear concept of what the pound and the gram, the centimeter and the foot, really are. Force and distance are, after all, things which the student can sense directly. The hybrid units based upon these concepts can, therefore, gradually assume significance. The difficulty then is not insuperable. But wait. Don't forget that having made these units based upon experience, clear and understandable, we physics teachers then turn around and insist that our students master another set of units, the *absolute*, understandings of which cannot be so based in experience. In fact a great deal of the difficulty that students have with physics comes from a needless—

Duplication of Units in Absolute and Gravitational Systems. Is this duplication necessary? Do students need to be taught to use (and to work problems in) both sets of units? ***Absolutely no!*** The *dyne*, that nebulous force which, "acting for one second upon a 1-gram mass, produces a change in its velocity of one centimeter per second," is not needed. We have the *gram*. Nor the *poundal*. We have the *pound*. Nor the absolute units of work the *erg*, the *joule*, the *foot-poundal*. We have the *gram-centimeter*, the *kilogram-meter*, and the *foot-pound*. Neither for the solution of problems, nor the satisfaction of college admission requirements, nor as preparation for college science courses are they needed. In fact, ***the absolute units have no place in high school physics at all!***

But if these units are discarded some changes will have to be made. Changes of fundamental importance—but simply and easily made. We will merely need to make sure that formulas are expressed so as to give answers in the gravitational system. After all only a few such formulas are customarily used in the high school physics course. In place of $F = Ma$, we write $F = Wa/g$. For centrifugal force, C.F. $= Wv^2/gr$; for kinetic energy, K.E. $= Wv^2/2g$; for potential energy, P.E. $= Wh$ (note the similarity to the *work* formula); for momentum (if we use the formula at all), Wv/g. We define the *watt* in terms of the volt and the *ampere*, in relation to horsepower, or as about 10,200 gram-centimeters per second, *but* never as 10,000 000 *ergs* per second. These we do—and carefully expunge all references to absolute units in the reading material—and the trick is done.

Confusing Terminology. In ordinary English usage the word "specific" means definite, precisely formulated. Yet the two physics terms *specific heat* and *specific gravity* are defined according to different patterns, the former as amount of heat that will raise the temperature of one gram of the substance one Centigrade degree, the latter as a ratio between weights of equal volumes of the substance under consideration, and water. The use of the word *specific* in relation to the latter definition is undoubtedly unfortunate. Specific gravity is not specifically defined. Confusion also arises from the difference in the kind of statement. Let us attempt to cast both definitions into the same form, a form which in spite of the word *specific* compares the substances to water in each case. "Specific gravity of a substance is the number of times that substance is as heavy as the same volume of water." Specific heat is harder to cast into the same mold but let's try it. "Specific heat of a substance is the number of times as much heat it requires to raise the temperature of a certain amount of the substance a certain number of degrees as is required to raise the temperature of the same weight of water the same number of degrees." Wordy, indeed, but understandable through discussion. The understandableness of these concepts would be enhanced if, in place of the present terms, new names of "relative heat capacity" and "relative weight" could be used for them.

Another instance of confused terminology arises in our usage of the term "index of refraction." Taken at its face value, the phrase should mean something which indicates the amount of bending (or refraction) that a beam of light will experience in a given situation. And so, basically, it does. But the ordinary definition states that it is the ratio of the speed of light in the substance under consideration to the speed in a vacuum. The solution would seem to lay in explaining that the amount of bending that the beam experiences depends upon the relative speed of light in the two media.

The Problem of the Volt. At this point, physics teachers are in a dilemma. We are damned by many college teachers if we teach that the volt is a unit of electrical pressure. Others expect such teaching, if they do not actually favor it. The difficulty arises from the fact that for most purposes on the advanced college level, it is best to think of the volt as that difference in potential energy against which one joule of work is done in transferring one coulomb of electricity. It is evident that, in terms of our

rejection of the absolute units, this definition is unacceptable for high school use. Let us try casting it in other terms. A simple analogy may help to make clear what is involved in this definition.

Let us imagine the one-pound weight of figure 1, raised to a height of four feet above the ground. We can define its position in two ways. It is four feet above the ground. It is also at that position where its potential energy with reference to the ground is four foot-pounds. The same is true for the other positions.

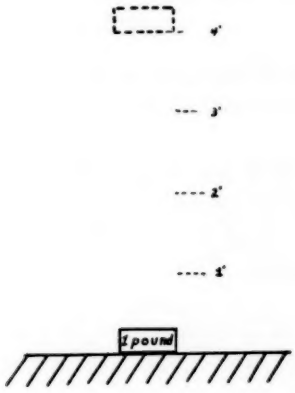


FIG. 1

Similarly the fall of the body from the four-foot to the three-foot level is a fall through an energy level of one foot-pound. Note that in order to describe correctly what has happened in such cases we need to know two things—the change in energy and the weight of the object. A change of one foot-pound means quite a different thing if the object weighs 5 pounds, or $\frac{1}{4}$ pound, rather than one pound. In the same way, to specify the volt we must know both the potential energy and the number of units of electricity. Figure 2 should help in this connection.

Suppose that the small body has been charged by adding about 6×10^{18} excess electrons to it. Without change in its charge, this object is moved away from the larger, positively charged body to position *B*. In doing so we have to do work on the small object because of the attraction of the larger body. Assume that we have done about 10,000 gram-centimeters of work against this electrical attraction. We have done ***one volt*** of work. That is, the body at position *B* has one volt more

potential energy than it had at A. Thus, in order to specify the volt, we need to know not only how much work has been done, but also the quantity of electrons upon which this work has been done. In other words, the dimensions of the volt are W/Q where W is work and Q the number of units of electricity.

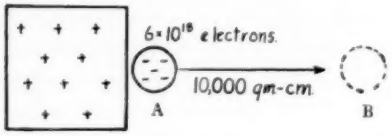


FIG. 2

Now any definition of the volt must pass the test of explaining how it is that the product of *volts* and *amperes* gives *watts*, a *power* unit.

From the definition of the ampere as the rate of current flow, we see that its dimensions are Q/t. Hence for volts x amperes we can write $(W/Q)\times(Q/t)$. Cancelling, we have simply W/t. But work/time is *power*. Thus the above definition of the volt meets this test.

Let us apply the same test to the volt as a unit of pressure. Pressure is force per unit area. Its dimensions therefore are force/area or F/l^2.

Evidently the product of these dimensions and the ones previously used for the ampere will not give power (W/t). However let us re-examine our notions of the ampere. The ampere is rate of current flow. Or we may think of it as measured by the number of electrons per second that move through a cross-section of a wire bearing the current (figure 3). These electrons are

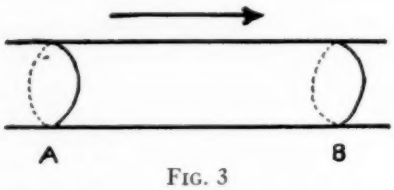


FIG. 3

drifting slowly along the wire toward B. Let us assume that we were able to take an instantaneous count of all such electrons in a given thin cross-section as at A. We make similar counts of electrons in other identical cross-sections. In every case the number of electrons is the same. Thus the flow of current may be thought of as an advancing front of electrons which in t

seconds has moved forward from A to B. In so doing it has distributed electrons uniformly through the space between A and B. The number of these electrons divided by the number of seconds is a measure of the rate of current flow. The greater the cross-sectional area at A and the greater the distance between A and B, the larger the number of electrons, that is the more the current. Hence the current is seen to vary directly with the product of the cross-sectional area and the distance and inversely with the time. That is, current depends upon (area $\times$length)/time. Or, the dimensions of current are $(l^2 \times l)/t$.

Using these dimensions, the product of volts and amperes can be seen to have the dimensions.

$$\frac{F}{l^2}\,(\text{volt}) \times \frac{l^2 \times l}{t}.$$

Cancelling the l^2 we get $(F \times l)/t$. But force$\times$length is *work*. And so, once again, the product of volts and amperes has been shown to be equal to work/time or *power*.

Both definitions are consistent. According to this one test, at least, both are "correct." Which shall we use? Whichever we wish. Preferring the first definition of the volt, but realizing its somewhat greater difficulty of comprehension, the writer has used the following plan. The ampere and the ohm are defined independently, the former in terms of number of electrons per second, the ohm in terms of the resistance of wire of a certain length and size. Then the volt may be defined as follows, "*If a current of one ampere is flowing along a wire between two points on which there is one ohm of resistance, then a difference of one volt of potential energy exists between the points.*" This procedure is open to some objection also, since some scientists would object to an independent definition of the ohm, insisting that it has meaning only in terms of the volt and the ampere. At the high school level it hardly seems that this objection can have much real validity.

Other Considerations. For some of the other problems growing out of the proliferation of units there may be no escape. It is probably necessary that we continue to teach both English and Metric units in a number of areas. In some instances it may be possible to eliminate, or largely to ignore, the less useful of two conversion factors. Use the mechanical equivalent of heat expressed in English units (1 B.T.U.-778 foot-pounds) rather than

the metric equivalent, the acceleration of gravity expressed in feet per sec.^{2} rather than in cm. per sec.^{2}, only one value for heat of vaporization and heat of fusion.

Finally, a technique described in another article in this series[1] may be used to prevent that confusion of units that often develops in solving problems.

[1] "The Plight of High School Physics. III. Mismanaged Mathematics." SCHOOL SCIENCE AND MATHEMATICS, 40: 368–376; 1940 (Apr).

CHEMISTRY MADE EASY

H. R. RAHN
Wells High School, Chicago

CHARACTERS

Dr. Gypsum
Clients A, B, C
Policeman, pretty girl, two celebrators, "water," thief, widow, several passers-by

TIME

Spring of 1932

ACT I

SCENE I. *A not too busy business street of a large town. The action of this scene takes place before a vacant shop which is for rent. Enter Dr. Gypsum.*

DR. GYPSUM. Zounds! but I'm proud of it. I must look at it again. (*He stops, sets down briefcase, unrolls large diploma and reads.*)

By Authority of the Board of Trustees of the
Shortcut Correspondence School
Benedictus T. Gypsum
has been admitted to the degree of
Doctor of Chemistry
and is entitled to all rights and
honors thereto appertaining.

Jeremiah Wise
President of School

Now to set up a shop and have the gold rolling in and my fame spreading out. Ere long my remedies in every chest and my name, Dr. Gypsum, on every tongue.

First a good location where many people pass, people that are not too well informed or disposed to question, folks who will believe but most of all buy. (*The doctor examines his surroundings carefully.*)

Well I guess this suits me to a t, a capital T.

Act II

Scene ii. *Same as before except that the vacant shop has been outfitted as a chemist's shop of many years ago. Much apparatus and many large and ponderous books are in evidence. A large sign states that the doctor is a consultant on chemical and related problems.*

Dr. Gypsum is seated at his table which is cluttered with various bottles, flasks, books, etc.

Enter Client A.

Client A. I noticed your sign, doctor, so I thought I had better drop in. I've had a bad skin rash for several days and I have been using sulphur ointment to heal it. As you can see I have not been getting very swift results. (*Client moves his head from side to side to show his reddened and ointmented face.*)

Dr. Gypsum. Of course you haven't been getting results. Discontinue the sulphur ointment and use my special preparation—elixir of sugar of lead. If that doesn't give immediate results, my name isn't Gypsum. Five dollars, please. (*Client departs with his new remedy after paying the required fee.*)

Dr. Gypsum. While I'm waiting for more clients, and I won't have to wait long, I'll start writing my chemistry book.

Zounds! but how a readable chemistry book is necessary. Almost all the books now used are so dry that a desert by comparison is a swamp. I'll . . . but here comes another client.

Good day, sir, and how may you be this fine morning?

Client B. Fine, doctor, but here's the rub. I've been putting on weight so fast that my clothes hardly fit me from one day to the next. What would you advise me to do?

Dr. Gypsum. Hm . . . so you want to reduce. (*The doctor looks around amongst his bottles and then pours some tablets from a colorless glass bottle into a box.*)

Take two of these mercurous chloride tablets after each meal. They are known as being good reducing agents. I'm sure that after you have taken them for a few days you won't have to pay me a second visit. Five dollars, please. (*Client pays and exits.*)

Now, my textbook. But my book can wait. (*The doctor puts his papers to one side as another client approaches.*)

CLIENT C. Say, doctor, I've got a little problem for you. I have been using glycerine in my automobile radiator last winter and now I find that dirt and rust have so thickened it that it will not drain out. How do you advise that I clean out the radiator?

DR. GYPSUM. I have always found aqua fortis to be a good cleansing agent. Add this quart of nitric acid to your radiator, run the engine for a few minutes to warm up the contents and then drain. That ought to end your problems.

(*During all of the foregoing, people have been passing occasionally on the sidewalk.*)

Now to get back to my book. The first thing to do is to find suitable symbols in place of words to represent elements and compounds. My idea is to use characters that will really enliven, animate the study of chemistry.

Now water is a very familiar material. How shall I represent that? Let me see . . .

(*Enter boy dressed in rubber boots, rubber hat, carrying a pail filled with finely cut paper and containing a cup filled with water. Boy goes to the doctor's table, takes out cup to pour the water into a jar. That leads audience to believe that the pail is filled with water. The boy seizes the bucket and throws contents out towards audience.*)

Ah ha. That's the symbol. (*Writes.*)

Now sugar, what shall I use to represent it? (*The doctor thinks hard and then his face brightens up as his eye lights on a pretty girl who is passing by on sidewalk.*)

I've got it! (*Writes.*) This book will have animation all right.

Gold . . . gold . . . (*Thinks; then spies his wallet on the table.*)

My wallet, and it will have a lot more gold in it by and by. (*Writes.*)

Now steel . . . steel . . .

(*Passerby, dressed as a thief wearing eye covering and carrying a sack, tiptoes through and snatches wallet as he passes table.*)

Hey! come back with my wallet. What a dirty steal! Ha! Steal . . . steel . . . that gives me an idea. (*Writes.*)

Alcohol . . . What shall I use for alcohol? . . .

(*Two boys dressed in evening clothes and carrying on hilariously pause at table to take out bottle containing liquor, i.e., ammoniacal solution containing phenolphthalein, from coat pocket. They are about to drink.*)

(*Dr. Gypsum nods wisely as he gets the idea for the symbol.*)

DR. GYPSUM. Now copper . . . copper . . . (*Scratches his head in deep thought.*)

TWO CELEBRATORS. Copper? (*Looking questioningly at each other.*) Copper? Whoa, let's get away from here! (*Each tries to pass bottle to the other and finally set it on table as they rush away.*)

(*Footsteps are heard off stage.*)

DR. GYPSUM. Hey! (*Shouts after celebrators, becomes quite nervous as he holds bottle and footsteps off the stage become louder. Finally in desperation he inverts bottle over tall cylinder which contains a small quantity of acid.*)

(*Policeman enters, looks suspiciously about and then exits. Dr. Gypsum writes after mopping brow.*)

ACT III

(*Several days elapse between the foregoing and the action which follows.*

To one side of stage gathers a small group of people consisting of Client A with his face blackened, the widow of Client B dressed in black and wearing veil, Client C with his arms and head in heavy bandages, and several passers-by, who were attracted by the discussion. The clients are relating their experiences in following the doctor's advice and are debating what to do with him. They suggest shooting and hanging but argue that would be too good for him. Dr. Gypsum, meanwhile, is busy with his book.)

DR. GYPSUM. Now the next one is barium . . . barium . . .

CLIENTS (*pricking up their ears*). Bury 'im? Bury 'im? That's it! Bury 'im alive! (*They rush at the doctor and as he struggles and remonstrates they carry him off the stage.*)

(*Curtain*)

SKELETON OF PRE-ICE-AGE ELEPHANT DISCOVERED IN SIBERIA

The skeleton of a young elephant that lived in Siberia shortly before the Pleistocene Ice Age has been unearthed near the town of Novosibirsk, according to word received here by Dr. Ales Hrdlicka of the U. S. National Museum. Skeletal remains of mammoths belonging to the Ice Age itself are found quite abundantly in northern lands; but the new specimen is of an earlier type of elephant with straighter tusks, that rates as a great rarity. No entire skeletion of this species has even been found in the USSR before.

The height of the skeleton is nearly nine feet, and the one tusk with it is five feet long. The bones are recognizable as those of a young animal because they are not hardened throughout but consist partly of cartilage.

FORCED INTO BUSINESS

The Needs of the Consumer Forces Chemistry Teachers to Become Conversant with Good Buys in Many Businesses

DAVID D. APTEKAR
Northwestern High School, Detroit, Michigan

The traditional treatment of high school chemistry is tottering on its staid throne. Instead of being confined to universities and commercial laboratories, the Age of Science has now penetrated into the consciousness of Mr. and Mrs. Citizen and their children, our students. As a result of this increased science consciousness, teachers of chemistry have felt new demands on their services. No longer is it sufficient to teach chemistry as a standardized subject; today we must be prepared to answer questions which our students bring in from home, and whose answers are not dealt with in any standard textbook.

"What kind of gasolene should we use?" "Which brand of milk is the best buy?" "How do we tell?" "Why is there such a difference in the price of cosmetics, and which do you recommend?" "How should our family go about picking out a refrigerator?" "What are 'skin-vitamins,' and what do they do?"

We've all heard these questions in our classrooms. They are the result of the great play given by advertisers to the "scientific angle" of their products. While a good deal of false advertising has done much to confuse and betray the public's confidence in the Scientific Age, much genuine benefit has resulted from an increased interest on the part of Mr. Average Man in the offerings of science.

It is no wonder, then, that the public is beginning to look to its schools for guidance and information on how to get the most for their money. Teachers of chemistry are one of the first to feel this new demand. Many of us have undoubtedly been embarrassed at our inability to answer these highly practical questions. Those of us who have accepted the challenge have uncovered much useful and interesting information. In digging out this material the chemistry teacher has been "forced into business," that is, he has found it necessary to carefully examine the relative merits of various products. He has had to make an analysis of what are the prime advantages and disadvantages of competitive brands of merchandise. He has had to cull out the fundamental principles which govern the manufacture and

use of different types of materials. He has had to gather together data on prices, wearing qualities, grades, and physical and chemical properties as related to value. All this information is now necessary if we are to be of real help to our students, the ultimate consumers.

The most difficult angle, at least from the writer's experience, has been to develop in the student the ability to apply the scientific method to his selection of materials he wishes to buy. To illustrate how completely unscientific and subjective we are likely to be in our buying of essentially a chemical material, we submit a record of some of the answers to a questionnaire given to a class of chemistry students at the start of a semester:

Question: "What brand of gasolene do your parents use, and why?"

Answers: "We use brand 'X' because,

a. If name is famous it must be good.
b. Lowest in price.
c. No special reason.
d. Recommended by next door neighbor.
e. Gas station attendant a friend.
f. Like their baseball broadcasts.
g. Nearest to our house.

Compare your reasons for buying your particular brand with the ones given above. Do your buy your kind because of any of these reasons, or do you buy it because you have made a careful analytical approach to the problem of selecting a gasolene best suited to your needs? To me it seems surprising how little of the "scientific attitude" permeates into our everyday living. One of the outstanding needs of our courses in science is the development of a technique which will produce more carryover of the scientific attitude into our daily life. This attitude is something which even we teachers are too inclined to limit to the confines of our classroom. Yet, with the bombardment of "scientific" advertising urging us to buy, the average citizen has every right to expect the schools to provide him with a tool with which to gauge, with a fortification which will protect him from sales appeal, and permit him to apply intelligence and objective evaluation in his purchasing.

Few of us fully realize the importance of being an intelligent consumer. While none of us as individuals spend large sums of money, there are few of us who aren't guilty of spending very

nearly 100% of our income. To us this means that we spend nearly all we earn and therefore, any techniques which we can learn which will help us to buy more intelligently and efficiently are of utmost importance. From groceries to automobiles, from meats to refrigerators, from electric fans to washing machines our knowledge and efforts must teach us to spend wisely.

Teachers who are incorporating this kind of material into their courses are finding it pays real dividends in increased interest, intenser cooperation of the pupils, and greater practical utility than is possible by strict adherence to the more orthodox methods of presentation of the chemistry course.

In this swing to consumer chemistry the need for cooperation of the schools with the community becomes more pronounced. In addition to more nearly answering the needs of the average student (nowadays the average student does not go to college) factories, civic agencies, business organizations, and other consumer groups may be contacted. For example, if we want to determine which brands of milk are most satisfactory we might find it desirable to talk with representatives of various creameries in order to discuss methods of testing and processing milk, determine what precautions are taken to insure proper delivery, and check quality control. In this way fair interpretations of results may be made. Such a procedure produces a spirit of civic cooperation and is probably more satisfactory than mere testing of samples purchased at a store without consulting the creameries. Some companies will even lend you equipment for testing purposes. Government agencies, also, are anxious to co-operate in supplying consumer information, and many bulletins and publications are available either free or at a very slight cost. By drawing in the various forces in the community you are vitalizing the course; you are making it more nearly answer the needs of your students.

One precaution should be observed in this trend which gives detailed information to the consumer. Let us not lose sight of the fact that products change, quality changes, standards change, and conditions change. Only the fundamental scientific truths which govern our choices do not change. We must, therefore, teach our students how to pick out fundamentals, how to apply the scientific method to his purchasing, how to discover what constants there are to depend on as a basis for his choice. Then, no matter what changes in product, no matter what particular brand we select as the "best buy" today, we will have

the means and the ability to constantly re-evaluate, and will therefore continue to get the most for our money.

Thus, the role of chemistry teacher has become a dynamic one. We constantly need to study new editions of standard products; we have to be on the alert for new materials, new equipment; we have to be in touch with new developments in industry and business. In short, we find ourselves "*forced into business*" in order that we may better serve the needs of a community which has awakened to the products of a scientific age.

HOW CAN TEXTBOOKS IN HIGH SCHOOL PHYSICS HELP IN GUIDING PUPILS IN SCIENTIFIC THINKING?

JAMES D. TELLER
Instructor in Education, Ohio State University

Textbooks in high school physics now on the market fall roughly into two great classes. In the first class we have books which bear such titles as *Elements of Physics*, *First Principles of Physics*, and *Mastery Units in Physics*. These books center attention on the basic generalizations of physics. The subject matter of this class of books is organized according to a logic which has become a dominant characteristic of the science of physics. None of these books fail to introduce applications of the principles treated; some show the historical background of certain principles; all pay lip service to the importance of developing a scientific method in the attack on man's problems. In the second class we include books having such titles as *Household Physics*, *Consumer Science*, and *Physics in Everyday Life*. These books purport to emphasize the applications of physical principles in relation to some important aspects of man's everyday living. These books supposedly have their subject matter arranged to give information on selected areas of personal and social needs. All of these books stress the applications of certain basic principles; some place a few principles in relation to their historical setting; none forget to include a paragraph or two on the place of scientific method in the solution of man's problems.

The above paragraph is not intended to imply that the title of a particular physics book would automatically classify it into one or the other of the two categories. The above titles are intended to suggest two trends which the author feels able to

discern in the writing of physics textbooks. The first trend has become traditional; the second arises out of the criticism leveled upon the logical organization of subject matter for high school students. The two trends are not mutually exclusive; they represent merely an emphasis. The books representing the first trend set up the basic principles of physics in bold-face type so that pupils are led to revere them as finished products of man's thinking. Physics is taught as a monument and not as a movement, as a set of ideas to be memorized and not as an activity in which to participate. On the other hand those books which may be regarded as representative of the second trend too often terminate in an "omnium gatherum" of facts, in scraps of undigested and unconnected information. Neither of these trends center attention on the scientific methods and attitudes of which the physical principles and their applications are products.

If then it is true that "training in scientific method . . . is the outcome of the technique employed in attaining an understanding of scientific principles and their application in new situations,"[1] it would seem that textbook writers must make a deliberate attempt to give more attention to the method of science than is common in present textbooks. Further they must analyze the method of science in such a way as to guide students in the use of that method. In short they must not only provide students with opportunities for solving problems but they must seek to habituate them in the scientific method of solving problems. Obviously neither the basic generalizations of physics nor the ways in which these impinge upon man's personal and social needs can be neglected, but students of physics must be made conscious of the safeguards which characterize scientific thinking and must be given many opportunities of engaging in this type of thinking.

With such a goal the selection of a group of problems to direct the thinking process becomes an important but difficult task for a textbook writer. The problems must be such as to arouse the curiosity of amateur scientists; they must deal with everyday happenings which are common to the lives of a large group of individuals; they must be varied enough as to give training in many different aspects of scientific method; they must be graded as to difficulty both for the different individuals of a group and for the same individual at different times.

[1] Beauchamp, W. L., *Instruction in Science*, pp. 42–43, United States Department of the Interior, Office of Education, Bulletin, 1932, No. 17.

In order to make a selection of problems which might arouse the curiosity of high school students, the textbook writer might collect the questions asked by students in many high school physics classes over a period of several years. The questions could then be classified according to the scientific principles needed to answer them. Those questions under each principle should then be sorted according to the opportunities which they seem to afford for giving training in various aspects of scientific method. Finally the principles themselves should be arranged in such an order that principles required for an understanding of later ones would receive consideration in the earlier units of study. Within this logical grouping of the principles, an organization of the units should be effected according to psychological and pedagogical considerations.

Thus, a unit of study would consist of a group of adolescent problems the solution of which required an understanding of certain related physical generalizations. In guiding the student toward an understanding of its problems the unit should utilize any device the worth of which psychological research or teaching experience has demonstrated. In all units a variety of experiences should be suggested.

Certain techniques should be aimed at arousing interest in an exploration of the problems. Each unit might be preceded by a full page picture preview of its problems. These pictures should be selected for their dramatic qualities. They should be accompanied by carefully phrased and dynamic preview questions. Spectacular demonstrations might be suggested for motivating some units. Each unit should be approached from concrete situations in everyday experience in order to motivate the student. Often contrast can be used to show the dramatic features of a principle: A common phenomenon can be contrasted with a different one which is imagined; a universal principle can be made vivid by imagining what would happen if it suddenly failed to act; a condition peculiar to certain substances can be compared to the same condition when it is imagined to be universal.

After a set of problems has been placed in intimate relationship to the student's life, the historical approach should be used to show how a scientist faced with one of these problems reached a solution. Attention should be centered at all times upon the method of solving the problem and not upon the conclusion. Significant steps in the solution should be placed in italics and

not the principle which the solution yielded. The detailed description of the classical experiments of physics constitute one of the more valuable aids in showing the ways in which man has reached a solution to problems which his curiosity set for him.

Controlled observation in the laboratory is an important element in scientific method. However, the role of the laboratory in high school physics is not to enable students to repeat uninteresting quantitative experiments in order to get results which will tally with those given in the text. A relatively small effort will suffice to teach students to follow the experimental directions of other investigators if they have first comprehended the basic concepts involved in these experiments. No, the role of the laboratory must not be limited to repeating the experiments of others; its chief function is to serve as a testing ground for hypotheses formulated by students. Accordingly the textbook should guide pupils in the formulation of hypotheses and in the experimental testing of these hypotheses. Horton's study[2] is suggestive to the textbook writer in this connection.

The above is not intended to imply that the training of students in the scientific use of the imagination will result in their arriving at the basic generalizations of physics. These are the products not of one century but of many centuries, not of one thinker but of many thinkers. To expect students to discover even the major principles of physics in an elementary course would be absurd; to expect them to engage in that type of mental activity from which these principles have resulted is essential if they are to be trained in the method of science.

It is not enough that amateurs be allowed to participate in those numerous activities which we associate with scientific method; these amateur scientists should know that the method in which they are training themselves has many accomplishments to its credit. It is therefore essential that the basic concepts of physics be stated in an easy to understand and interesting to read manner. These statements should be made in a variety of ways so that the concepts may be more easily understood; the representation of certain principles by means of simple algebraic formulae should be employed; simple numerical problems should be used to illustrate the formulae; well selected photographs and drawings should illustrate important mean-

[2] Horton, R. E., *Measurable Outcomes of Individual Laboratory Work in High School Chemistry*, New York, Bureau of Publications, T. C., Columbia Univ., 1928.

ings; the application of the principle in making intelligible some common facts should be shown; outlines should be constructed to show relationships; principles should be summarized by a series of clearly phrased and well ordered questions; self-diagnostic activities not only of understandings but also of methods should be provided; and above all a series of well motivated qualitative problems should enable the pupil to apply his understandings to a new situation and to use scientific method in his attack.

The introductory unit should not be a unit on measurement. The author's experience is that boys and girls have little or no interest in measurements until they study something which needs to be measured. Consequently the various instruments and units used in measurement should be included in those units of study where particular measures aid in clarifying certain concepts. Although metric units as well as English should be used, the discussions of the particular units should be introduced when needed. Even though his students came to him as ignorant of the metric system as those of other teachers, the author does not believe this to be sufficient excuse for presenting it as an introduction to physics. To plunge the student into such a mass of unfamiliar and uninteresting material at the beginning of his work in physics is to give him a chronic case of mental indigestion for the duration of the course.

Neither should the introductory unit be concerned with the formal definition of concepts with which the student has had little experience. Instead the introductory unit should introduce the elements of scientific thinking as illustrated in situations familiar to the student. These elements could then be presented in several historical situations. Downing's study[3] is suggestive for this purpose. It is important that the introductory unit present physics as an ongoing concern and not as a cut and dried product of human thinking.

Although the organization of physics courses as now presented shows a high degree of uniformity,[4] textbook writers interested in guiding pupils in scientific thinking should feel free to experiment with different organizations of units which center in adolescent problems. The author presents the following as a list of units which he has found useful in his own classes:

---

[3] Downing, E. R., "The Elements and Safeguards of Scientific Thinking," *The Scientific Monthly*, Vol. 26, pp. 231–243, Mar. 1928.

[4] Beauchamp, W. L., *op. cit.*, pp. 35–36.

Units for a Year's Program of Guided Thinking in Physics

1. Scientific method is helping man to progress in the solution of his problems.
2. Newton uses scientific method in his thinking about a falling apple.
3. Pascal thinks scientifically about a cask and tube filled with water.
4. Archimedes applies scientific method in determining the purity of a king's gold crown.
5. Torricelli, von Guericke, and Boyle study air pressure scientifically.
6. Count Zeppelin experiments with dirigible balloons.
7. Orville and Wilbur Wright make the first successful airplane flight.
8. Galileo studies falling bodies experimentally.
9. Newton and Einstein formulate some hypotheses about motion.
10. Archimedes applies mathematics to the study of simple machines.
11. The Marquis of Worcester attempts to construct a perpetual motion wheel.
12. Robert Brown discovers ocular evidence of the molecular movement postulated in the kinetic molecular theory of matter.
13. Fahrenheit and Celsius devise scales to measure temperature.
14. Count Rumford offers evidence against the caloric theory of heat.
15. Dewar utilizes his knowledge of the principles of heat transmission to construct a thermos bottle.
16. John Tyndall studies the motions of glaciers.
17. Cailletet liquefies air and other gases.
18. James Watt perfects Newcomen's steam engine.
19. Professor Foley photographs sound waves.
20. Professor Miller studies musical sounds scientifically.
21. Franklin experiments with a kite and lightning.
22. Galvani and Volta investigate the production of electricity by chemical means.
23. Ohm mathematically investigates the relation between electrical pressure, resistance, and current.
24. Edison invents a practical incandescent electric light.
25. Gilbert experiments with magnetism.
26. Oersted and Henry experiment with the magnetic effects of the electric current.
27. Faraday experiments with electromagnetic induction.
28. Hertz discovers invisible waves capable of carrying messages.
29. Huygens proposes a wave theory of light.
30. Euclid states the law of reflection of light.
31. Snell discovers the laws of refraction of light.
32. Helmholtz investigates the eye as an optical instrument.
33. Newton performs his "experiment of colours."
34. Some problems which physicists have failed to solve.

BATHYSPHERE TO BE USED FOR SCIENTIFIC STUDY OF OCEAN DEPTHS

A bathysphere is now under construction in Leningrad, a TASS dispatch indicates. It is to be used for scientific study in oceanic depths.

Unlike previously constructed devices of its kind, the new Russian bathysphere will not require a ship to let it down and haul it up on a cable, the Soviet news agency states. The diving globe is expected to descend to depths of more than a mile and a half and to come to the surface again under its own power, controlled by its crew of two men. It is claimed that it will be able to remain submerged for ten or fifteen hours.

THE CRUCIAL PLACE OF SEVENTH AND EIGHTH GRADE MATHEMATICS IN EDUCATION FOR COMPETENCY*

H. C. CHRISTOFFERSON
Miami University, Oxford, Ohio

Deferring the teaching of some processes in arithmetic from early to later grades, the increase in the "no failure" philosophy of education, and other factors, such as a greatly enriched curriculum, have combined to produce a crisis in the mathematical education of junior high school pupils. Add to this the fact that few schools require any mathematics beyond the junior high school and you can readily appreciate why and how the junior high school mathematics teacher is "on the spot." It must be the aim of the schools to produce competent citizens, young people who can deal accurately and confidently with quantitative problems of all kinds, as well as those who can deal with social and health problems. Our civilization is becoming daily more and more scientific and complex, and therefore demands men and women trained in science and mathematics. Such scientific and mathematical training means more than the attainment of mere manipulative and computational skills however. Our present society demands boys and girls, men and women, who have scientific attitudes, who can think clearly in quantitative situations, who can analyze and evaluate conclusions on the basis of data.

It shall not be the purpose of this paper to attack the causes which have precipitated this heavy load upon the junior high school teachers of mathematics, nor to attempt to lighten that load. It shall rather be my purpose to attempt to clarify the problem by revealing the most evident needs, and to stimulate teachers to shoulder that load more willingly and intelligently.

Clarification of the problem can probably be most readily achieved through the inspection of some mass measures of attainment. In Ohio the best mass measures that we have are the Every-Pupil Tests given in December and April each year. For the last several years the mathematics tests have emphasized the two major features of mathematics, namely, computation and problem solving. More significantly stated the tests have

* Read before the Junior High School Section of the Annual Convention of the Central Association of Science and Mathematics Teachers, Cleveland, Nov. 23, 1940.

attempted to measure, first, the acquisition of the necessary computational skills; second, the attainment of the ability to think clearly in quantitative situations, to organize and to interpret data, to choose and to utilize the necessary mathematical processes for obtaining and establishing a conclusion. The following data indicate the achievement level which has been attained and therefore also by implication the areas upon which greater stress must be placed.

The April Every-Pupil Test for the Eighth Grade reveals achievement in the mechanical phases of mathematics which is not bad considering the fact that summaries of test results

A COMPUTATIONAL PICTURE OF OHIO SEVENTH AND EIGHTH GRADES BASED ON SAMPLES OF RESULTS FROM EVERY PUPIL TESTS IN 1935, 1936, 1937, 1938

1. Computations which 90% or more can do accurately:

December 7th Graders (Average 8323 pupils)	*December 8th Graders (Average 7976 pupils)*
Place the decimal point in the answer to this problem:	Same as 7th grade plus
$4\frac{5}{8}$ 378.2	3.04 and 352
$-1\frac{1}{2}$ 3.42	$\times 3.1$ 594
1294812	803
	769

2. Computations which 70% to 90% can do accurately:

7th Grade

a. Whole numbers

			238
			615
18703	820	9)3605	766
-9058	$\times 572$		489
		9)180916	947

b. Fractions, including decimals

$4\frac{1}{2} \times 6\frac{2}{3} =$

$1.5 + .23 + 18. =$

Place the decimal point in:

$$.41\overline{)13.1405}\quad 3205$$

465.07
-94.58
3.04
$\times 3.1$

8th Grade

Add to 7th grade examples

$\frac{3}{4}$ of 424

$25.13 - 12.3 =$

$\frac{5}{6} =$ _____%

$7/12 \div \frac{3}{4} =$

Deduct

$4\frac{1}{2} \times 6\frac{2}{3}$

820	18703
$\times 572$	-9058

3. Computations which 50% to 70% can perform:

7th Grade	*8th Grade*
a. Whole numbers $705\overline{)26085}$ $\quad$ $17\overline{)17136}$ b. Fractions $3\frac{1}{2}$ $\quad$ $17\frac{1}{4}$ $\quad$ $57\frac{3}{4}$ $\quad$ $8\frac{5}{12}$ $\quad$ $87\frac{1}{3}$ $\quad$ $94\frac{3}{4}$ $\quad$ $-1\frac{2}{3}$ $\quad$ $48\frac{3}{4}$ $.45\overline{)9.585}$ $\quad$ $25.13-12.3$ $\frac{3}{5}=$ ____% $20-3.825=$ 8% of 26 = $\quad$ $7/12\div\frac{3}{4}=$ 4% of 1739 = $\quad$ $3\frac{3}{4}\div 2=$ $\frac{3}{4}$ of 424 = $\quad$ $62\frac{1}{2}\div 8\frac{1}{3}=$ Read a line graph of attendance to tell the per cent of attendance on Tuesday.	Add to 7th grade examples $2.45\times 3\ 1/7=$ $\quad$ 36 is ____% of 72 28% of 72 = $\quad$ 80 is 20% of ____ 135% of 2200 = $\quad$ 1.2 = ____% $.48\overline{)72}$ $\quad$ $4\frac{1}{2}\times 6\frac{3}{4}=$ 820 $\quad$ 18703 $\times 572$ $\quad$ -9058 Change $7\frac{3}{4}$ to an improper fraction.

4. Computations which 30% to 50% can perform:

7th Grade	*8th Grade*
28% of 72 = $\quad$ $.834\overline{)91.74}$ 36 is ____% of 72 $\quad$ $.48\overline{)72}$ 9 is ____% of 12 $\quad$ $2.45\times 3\ 1/7$ 135% of \$2200 = Add: $\frac{1}{3}$, 5/12, $1\frac{1}{2}$, $2\frac{5}{6}$. Change $7\frac{3}{4}$ to an improper fraction. Change $\frac{3}{4}$ to a decimal. Find the perimeter of a triangular lot, given the sides.	87 = 12% of ____ 12 is 5% of ____ $12^2=$ ____ A decrease from 200 to 150 is a ____% decrease.

5. Computations which 10% to 30% can perform:

7th Grade	*8th Grade*
24% of ____ = 72 $\quad$ 12 is 5% of ____ 80 is 20% of ____ $\quad$ 87 is 12% of ____ 1.2 = ____% \$171 is ____% of 950	Add to the 7th Grade $1476\div 2.99=$ ____ (to nearest tenth).

6. Computations correct by less than 10%

7th Grade	*8th Grade*
$1476\div 2.99=$ ____ (nearest tenth). $12^2=$ ____	No computation was worked incorrectly by less than 12% of 8th graders.

are never extravagant. There seems very little to boast about, yet it must always be remembered that tests covering a range of items in a limited time and of the short answer type never give a complete picture of the tested students. Added to arithmetic skills there is revealed considerable knowledge of the vocabulary, constructions, and computations of geometry, and of the terms and processes of business such as promissory notes, installment buying, and insurance premiums.

Practically all of the examples with whole numbers, common and decimal fractions fall above the 70% level, although too many are still between the 40% and 70% marks. Below the 30% level there were five examples, "the area of a circle with radius 3 inches," "the volume of a cylinder given the height and radius," the square root of 500, $8\overline{)64080}$, and "an increase from 50 to 100 is a ____% increase." These data further confirm the statement that mathematical skills, while far from well mastered, are, relatively speaking, reasonably well developed.

A Problem Solving Picture of Ohio Seventh and Eighth Graders

Attainment in Problem Solving Based on Samples of Results from the Ohio Every-Pupil Test in 1935, 6, 7, 8.

Seventh Grade, December	Eighth Grade, April
I Problems which over 90% of junior high pupils can work accurately	
7th Grade	*8th Grade*
No Problems	No problems
II Problems which can be solved by from 70% to 90% of the pupils	
7th Grade	*8th Grade*
Jane bought $3\frac{1}{2}$ yards of material for a dress. She had to buy $\frac{3}{8}$ yd. more than she could finish the dress. The number of yds. required for the dress is: (A) $3\frac{1}{2}-\frac{3}{8}$; (B) $3\frac{1}{2}+\frac{3}{8}$; (C) $3\frac{1}{2}\div\frac{3}{8}$.	Mr. Carson bought a house for \$3250. After he spent \$820 for repairs, he sold it for \$4500. How much did he gain?
The storekeeper gives you the following coins as your change out of \$5.00 when your total purchases amounted to \$3.65, a ten-cent piece, a twenty-five cent piece, and a dollar bill. Is this correct change?	Mr. Miller insured his house for \$7000. He had to pay a yearly premium of 25 cents for each \$100 of insurance. What was his premium for one year?

Ability to solve problems as revealed by these tests seemed quite different from computational skill. Just as there were practically no examples which less than ten per cent of even beginning seventh graders could work, so there were no problems listed by the authors which were easy enough for 90% of the seventh or eighth graders to work correctly in either the December or April Tests. The following problem from the April test rated highest. "A school club has 19 members who pay 20 cents a semester dues. How much money will be collected in two semesters?" This was solved correctly by 69% of the seventh graders and 86% of the eighth graders. The accompanying table attempts to picture on a scale the problem solving abilities of seventh and eighth graders.

In Algebra a summary for the ninth grade similar to that given for the seventh and eighth grades again reveals reasonable success in mechanical skill in both December and April. In the vocabulary and fundamental concepts portions of the April tests, there were no examples below the 30% mark and only 10 below the 50% mark.

In problem solving there were no problems easy enough to be solved by 90% of the pupils, none easy enough to be solved by 80%, nor were there any which 70% could solve correctly, and

III Problems which can be solved by from 50% to 70% of the pupils

7th Grade	*8th Grade*
If my automobile speedometer registered 14,796.6 miles when I started on a trip and 23,472.3 miles when I returned, how far did I travel?	A dealer buys radios for \$40 each, and sells them at $37\frac{1}{2}\%$ gain on the cost. What was the selling price of each radio?
Edward's allowance for a month is \$2.25. He plans to spend \$1.60 of this amount each month and save the balance. He will have saved how much at the end of one year?	Find A in the formula, $A = \frac{1}{2}\ bh$, if $b = 16''$ and $h = 5''$.
Which of the following prices on oranges is the cheapest? 45 cents a doz.; 4 cents each; 3 for 10 cents?	Coal bought for \$5.50 in the summer months sold for \$8.75 from October to April. How much was saved on the winter's supply of 8 tons by buying it in the summer?
John earned \$1.75 on Monday, \$1.25 on Tuesday, \$1.50 on Wednesday, \$2.00 on Thursday, \$1.50 on Friday, and \$.90 on Saturday. What was his average wage per day?	This year the P.T.A. started the year with a bank balance of \$785.50. During the year they wrote checks for \$196.50 and deposited \$152.00. What is their bank balance for the end of the year?

IV Problems which can be solved by from 30% to 50% of the pupils

7th Grade	*8th Grade*
John buys papers for \$1.80 per hundred and sells them at 5 cents each. How much does he make on 200 papers?	A grocer bought a case of canned peaches containing 24 cans for \$4.08 and sold them at 20 cents per can. What was his profit per can?
The Los Angeles newspaper stated that in 1932 approximately 1000 athletes tried out for the events. On a bar graph they let a bar 1″ long represent 1000 men. In 1936, 2750 men tried out. How long would they make a bar to represent 1936?	A carpenter bought 3 kegs of nails. 50 lbs. to the keg. The cost was 3 cents per pound less 10% for cash. Find the net cost, if he paid cash.
To run his store and make a fair profit, Mr. Green determines the S. P. of an article by adding 50% of the first cost to the first cost. What is the S. P. of a book, the first cost of which is 90 cents?	Mr. Nelson has a grain bin that is 5 ft. deep, 18 ft. long, and 6 ft. wide. Allowing 0.8 bu. of grain to a cu. ft., how many bushels will be have in the bin when it is full?

V Problems which can be solved by from 10% to 30% of the pupils

7th Grade	*8th Grade*
A gallon of floor dressing will cover 450 sq. ft. of surface. How many gallons will be needed for our gymnasium floor which is 60 ft. long and 40 ft. wide?	Elizabeth's class is earning money to buy a basketball. They pay \$.80 for a box of 24 bars of candy which they sell at 5 cents a bar. What per cent of the selling price do they make?
Before the boys left, they bought a used trunk for \$6.50 and paid \$2.10 for waterproof cloth with which to cover it. When they returned they sold the trunk for \$10.75. What was their per cent of profit on the cost?	Of the 900 pupils in school, 200 pupils will not have anticipated in preparing correlated units. On a circle graph, how many degrees will be in the angle which represents the number who will not participate?
Gerald was paid 10 cents per yard for trimming hedge. How much would he earn for trimming a hedge enclosing a lot 40 yards long and 20 yards wide?	John finds that the 300 watt motor of their electric refrigerator runs 8 hours a day. To the nearest cent, what is the daily cost of the current 7 cents per K. W. H.?

only one in the 60–70% group. It follows. "If one side of a square is $2s$, what is the perimeter?" There was one also in the 50–60% group, and all the rest were solved correctly by less than 50% of the ninth graders.

What is the meaning of this tabular picture? Mathematics

VI Problems which can be solved by less than 10%

7th Grade	*8th Grade*
John's father bought a radio marked at \$75 less a 25% discount. If he received another discount of 5% for paying cash, how much did he pay for the radio?	The arithmetic class is building a track to show the relation of the diameter to the circumference of a wheel. If the wheel is to make 6 revolutions and is 26″ in diameter, how long must they make their track? (Use $\pi = 3.14$.) Express answer to the nearest foot.
Mary's flower plot contains 40 sq. ft. and Susan's flower plot is 40 ft. square. Which is the larger and how much?	

teaching should make two major contributions to a child's education. First, it should provide him with mechanical skills dealing with the number system of arithmetic, the concepts and the principles of geometry, and the generalized symbolism of algebra. Second, it should provide him with experiences in the use of these processes so that he will be able to think through quantitative situations, select and use the right processes, and finally to get the correct solution to problems.

Judging by these data, not only do pupils come to us in the seventh grade apparently with inadequate experiences for attaining the second of these educational values, but also they leave the junior high school at the eighth grade and ninth grade levels still woefully short in their ability to think through quantitative situations; short in their ability to analyze, organize, and evaluate data; short in their ability to utilize their skills in solving problems.

It is needless to quote authorities in the defense of this second objective. Every recent book or article on the teaching of mathematics emphasizes meaningful teaching of useful skills so that they may be utilized in the attainment of the major objective of mathematics, the ability to think clearly in quantitative situations.

Recently the War Preparedness Committee made the following recommendation. "That all competent students in the Secondary School take the maximum amount of mathematics available in their institution. In the case of many schools additions to the present curriculum will be necessary to furnish an adequate background for the military needs of the country." The aviator, the army engineer, the scientist, the manufacturer, the farmer, the merchant, the housewife, each need, not mere

computational skill, but real understanding of those skills and the ability to utilize skills in solving problems.

The mathematics teachers in the junior high school have a crucial place in the whole educational structure at the present time. Upon them falls the crucial task of insuring to every boy and girl the best possible mathematical training. Upon them rests the responsibility of developing those abilities which are so vital for competency in our modern society. To them comes the opportunity for helping children to learn how to use the universal language of quantity called mathematics in thinking through and solving quantitative problems.

The data submitted seem to indicate that for competency the educational attainments in mathematics are meager, especially in the thinking aspects of the subject. This must inevitably be the result of two forces, first, the various curriculum changes which have given to mathematics a proportionally smaller share of the student's time. From being $\frac{1}{3}$ of the three R's, mathematics is fortunate to get $\frac{1}{8}$ of a four-year-high-school student's time, or $\frac{1}{5}$ of a junior-high-school pupil's time. Secondly, mathematics is such an exact subject and submits to rules so readily that many teachers teach it as a purely mechanical course involving no thinking at all, merely following rules, and working the problems like the sample.

As teachers, there is little that we can do to change the curriculum even if we wanted to do so, but there is much that we can do to change our methods of teaching so as constantly to keep in mind that even in teaching skills, "skill alone is worthwhile, but skill with understanding is education." Skill, alone, may be sufficient in a totalitarian system of government, but skill with understanding must dominate to produce a competent individual in a democracy.

WAR HAS PREVENTED CHANGE IN ELECTRIC AND MAGNETIC UNITS

An effect of the war, so far unknown to most persons, was described by Prof. Noel C. Little, of Bowdoin College. By international agreement, scientists had decided to make a change in electric and magnetic units at the beginning of this year. Because of the war, this change was postponed.

On account of this, he told the American Association of Physics Teachers, attention of teachers of physics has been focussed on fundamental units and concepts. He gave the details of a new experiment that could be performed in intermediate classes to measure some of these relations.

AMATEUR TELESCOPE-MAKING

JAMES L. RUSSELL
Baldwin-Wallace Observatory, Berea, Ohio: Co-Director
Star-Gazer's Club broadcasts (Station W.T.A.M.)

We read in various publications of the great difficulties and cost incurred in the making of the giant telescopes. We question whether a home-made instrument could be of any practical value. Only recently has the public begun to realize that it does not take a super man with means to make a very serviceable instrument.

True, the first instrument may be a little crude, but it need not under any circumstance be a failure. Many a wide-awake high-school boy, possessing nothing but dime-store tools, has made an instrument at a cost of not more than fifteen dollars and a month or so of spare time. A six-inch instrument will reveal the mountains and craters of the moon the bands and moons of Jupiter the rings of Saturn, nebulae, comets, star clusters, and many other celestial phenomena. An inexpensive erecting eyepiece can be purchased for terrestrial use.

The beginner, even if he is a skilful mechanic or trained engineer, should start modestly, or he is surely doomed to failure. A six-inch mirror is large enough for a beginning. If this is done well, he can attempt a larger one. Pay attention to details and do not be in haste to get the first look into the sky. ***Finish the mirror.*** Many a young man has been disillusioned by his first glimpse into the sky from an unfinished mirror, done in haste.

The Mirror, or Speculum. The mirror is the most important part of the instrument. Its sole purpose is to gather the light from a star, the way a tub gathers rain, and to reflect this light in a cone-shaped beam to a point in front of the mirror where it can be viewed and magnified with an eyepiece. The point where the rays converge is called the *focus*. The length of the cone of light is called the *focal length*. But we cannot view the focal point while it is in front of the mirror. The observer's head would interfere with the light from the star. Our problem, then, is to mount a small flat diagonal mirror, or prism, in the tube of the telescope to intercept this beam at a point where it can be reflected at right angles out through a hole in the tube. The focus then falls just outside the tube where the eyepiece is affixed. One looks into the side of a reflecting telescope and not into the end as in a refractor-type telescope.

Equipment. It is recommended that the beginner purchase one of the numerous telescope-making kits for about five dollars found advertised[1] in each issue of *Scientific American*. The necessary material cannot be assembled individually for this price.[2] An assortment of other inexpensive things will be needed, such as a vinegar barrel for a grinding bench, several ten-cent-store pots and pans, some old towels, absorbent cotton to dry off the mirror, two or three scrubbing brushes, and other things that will suggest themselves as the work progresses.

Last but not least, the amateur should provide himself with a copy of *Amateur Telescope Making*, Scientific American Publishing Company, New York, price $3.50. This five-hundred page complete treatise is the telescope maker's "Bible." It contains about all that is known on the subject, with hundreds of illustrations.[3] This book can be obtained at most larger libraries.

Grinding. This consists of giving one side of the mirror a concave polished surface. When two flat discs are ground together with abrasive between them, something remarkable happens. The top disc gradually becomes concave, while the lower one becomes convex. The top disc will be our mirror. The lower one, called the tool, will ultimately be discarded. The longer we grind, the deeper the curves. Start with long strokes, using coarse abrasive. Finish off with short two-inch strokes, using fine abrasive. This tends to create and keep a spherical curve on the surface of the mirror. Longer strokes deepen; shorter ones flatten. Here lies the secret! Your entire problem throughout is to control the curvature of the surface of the mirror in this manner.

But how deep shall our curve have to be? This figure is in direct proportion to the focal length of the mirror. In other

---

[1] John M. Pierce, #11 Harvard Street, Springfield, Vermont; M. Chalfin, 1425 Longfellow Avenue, New York City; Tinsley Laboratories, 2035 Ashby Avenue, Berkeley, California; Precision Optical Supply Co., 991 E. 163rd Street, New York City; C. C. Young, 517 Main Street, East Hartford, Conn.

[2] *Glass mirror and tool blanks.* See (1) *Pyrex glass*, Corning Glass Works, Corning, N. Y. *Carborundum.* The Carborundum Co., Buffalo, New York. Branches all large cities. *Tempered Pitch.* See (1); *H.C.F., or Honey Comb Foundation;* A. I. Root Co., Medina, Ohio; Sears Roebuck & Company; or at any bee-keeper supply house. *Eyepieces, prisms,* John M. Pierce, Springfield, Vermont; Spencer Lens Company, Buffalo, New York; Bausch and Lomb Optical Co., Rochester, N. Y.; also see (1). *Brass Tubing,* snug fitting for eyepieces, John M. Pierce, Springfield, Vermont. *Aluminizing,* Leroy M.E. Clausing, 720 Greenwood Avenue, Wilmette, Illinois; John M. Pierce, Springfield, Vermont. *Mountings.* See *Amateur Telescope Making. Rouge,* American Optical Company, Southbridge, Mass. Branches in most large cities.

[3] The Perine Book Company, Minneapolis, Minn., publishes a good little book by W. F. Decker covering the subject. Another publication, *The Amateur Telescope,* by Rev. Wm. F. A. Ellison, published in Ireland, is very complete.

words, how long shall we make our telescope?[4] Let us decide on sixty inches, which is the average.

Having decided on the focal length, we must calculate the depth of our cut. The formula for finding this fact is: Depth $=r^2/4F$, where "r" is one-half the diameter of the mirror (three inches in our case) and "F" is the focal length decided upon. In the instant case it would be Depth $=(3\times3)/(4\times60)$, or .0375 inches. A very shallow curve, to be sure. To measure this curve when rough grinding, we place a steel straightedge across the cleaned surface of the mirror and attempt to slip under it the leaves of an automobile valve-feeler. The leaves of the feeler are marked in thousandths of an inch. If no feelers are available, it should be remembered that a piece of twenty-gauge sheet-iron is just .0375 inches in thickness. Other tests should be made as a check on this one.[5]

Polishing. The polishing is done on tempered[6] pitch, which is poured on the glass tool blank to a depth of about one-quarter inch, or you may use beeswax in the form of honeycomb foundation.[2] This is known as the H.C.F. method.[7] The abrasive used in this operation is iron oxide, known as rouge. The rouge can be purchased in bulk at any optical supply house for about fifty cents a pound.[2] It should be mixed with water to a thin paste and squeezed through a piece of cloth to remove any grit or dirt. The polishing is done the same as grinding. The stroke is reduced to about two inches. One should read all the chapters on polishing he can obtain before starting. The real trick is in the polish. As the mirror polishes, we must keep an accurate tab on the curvature of our mirror by means of the knife-edge, or "Foucalt's Test."

The Foucalt Test. About one hundred years ago a Frenchman named M. Foucalt invented a very simple device to determine the curvature of the surface of the mirror. It consists now of an artificial star, made from a tin can with a tiny hole in the side of it, inverted over a fifteen-watt electric-light bulb, placed at the locus of the curvature[8] of the mirror. The surface of the mirror receives the light and returns the beam exactly to its source if

---

[4] For discussion of focal lengths, see chapter on "Richestfield" telescopes, *Amateur Telescope Making, Advanced*. Also see article in SCHOOL SCIENCE AND MATHEMATICS, May, 1940, page 476.

[5] "Spit Test." See *Amateur Telescope Making*.

[6] The pitch must be the right consistency. It can be purchased made up for very little. See (1).

[7] See chapter on The New H.C.F. Method, *Amateur Telescope Making*, before you attempt to polish with pitch.

[8] The "radius of curvature" is always twice the "focal length."

the mirror is perfect. If, while viewing the returning beam, the edge of a knife or straight-edge is allowed slowly to interfere with it at the point of focus, shadows will seem to appear on the surface of the mirror. By means of the interpretation of the depth and position of these shadows, it can be determined to much less than a millionth of an inch the true curvature of the mirror. This experiment should be performed with care and patience.

Parabolizing. If the surface of the mirror were left spherical, it would produce a hazy image. Only a parabolic surface will focus all the light rays to a single point. The more or less spherical surface of the mirror must therefore be deepened very, very slightly. This is done by short polishing periods with a long stroke, or overhang stroke. Great care should be taken at this point. Try to interpret the knife-edge shadows correctly, so that you will recognize the parabolic shadow.

Aluminizing. Mirrors are no longer silvered. The silver tarnishes very rapidly. The modern way is to have a thin coat of aluminum spread on the surface. This aluminum immediately covers itself with a transparent coat of oxide, protecting the surface for years. A finished mirror can be shipped to any one of several laboratories throughout the country which will do the job for you for $2.50.[2] (You cannot aluminize your own mirror without expensive equipment.)

The Diagonal. This is a piece of good-grade plate-glass about $\frac{1}{4}$ inch$\times 1\frac{3}{4}$ inch$\times 2$ inches. Broken windshield is suitable. It must be aluminized on one side and should accompany the mirror to the aluminizer. When this is mounted at a 45° angle on a support in the center of the tube, it serves to deflect the converging rays from the mirror out through a hole in the side of the tube where they can be viewed with an eye-piece. This diagonal should be mounted so that it is easily adjustable.

The Cell. The finished mirror must be supported at the end of the tube so that its imaginary axis will pass down the center of the tube to the diagonal, which in turn will reflect the beam out the side of the tube. These cells may be made out of wood or metal. Finished aluminum cells can be purchased at a very reasonable price from supply houses.[1] The mirror should not be cemented or anchored solidly in a home-made cell but seated on sponge rubber pads to allow for expansion and contraction of the glass with the change of temperature.

The Tube. A tube can be made out of 22-gauge sheet-iron with

the ends uncrinkled. It should be sixty inches long. It can be made by almost any furnace shop at the cost of about $1.00. A hole is cut in the side of the tube near one end to allow the light rays to emerge from the diagonal. For all practical purposes no tube is necessary at all. It can be replaced by a heavy oak supporting bar. Pictures of several can be found in ***Amateur Telescope Making***. The tube serves only to protect the mirror and diagonal from extraneous light. It must be painted dull black on the inside.

The Eyepiece. The eyepiece is the magnifier. It is mounted on the tube over the diagonal at the focal point where the beam emerges from the mirror. Eyepieces can be purchased from various optical shops throughout the country for one dollar and up.[1] A low-powered eyepiece is recommended for the beginner. Unless the mirror is exceptionally well made, it will not stand high power. The image will be confused and blurred. Eyepieces are rated according to their focal length. A $1\frac{1}{2}$-inch eyepiece would be low power, then on up through 1 inch, $\frac{3}{4}$ inch. One-half inch would be high power. The magnifying power of the telescope is F/f, where F is focal length of the mirror and f is focal length of eyepiece in inches.

The Mounting. There are many different kinds of mountings. (See *Mechanics of the Telescope*, E. P. Burrell, 1931. Published by Astronomy Society of the Pacific.) Each amateur has his own ideas. Let us just give a word of advice here. A complicated mounting is unnecessary. It should be simple but as rigid as possible under the circumstances. If the mounting must be portable, then of course it must be made lighter. The mounting should be as jiggle-proof as possible. Mountings can be fashioned out of iron pipe fittings, old automobile parts, and out of wood. If the factors that really count are given close attention, the external appearance of the instrument does not matter.

Adjusting. When all the parts are mounted, they must be accurately adjusted. First remove the eyepiece. From a point a foot away, sight into the eyepiece-hole in the tube. Adjust the mirror and diagonal so that the round image of the mirror and the image of your eye reflected back from the mirror are centered on the diagonal. Replace the eyepiece and adjust it up or down until the object, star or moon, is in focus. If your image is not clear or a flare develops, adjust some more. The optical parts must be exactly in line for perfect results. First adjustment should be made on the moon, second on a bright star, and the

third fine adjustment should be made while observing a close double star, such as *Mizar* in *Ursa Major*. Adjust your parts until your instrument will separate the two close components of this star. It takes a pretty fair machine to accomplish this. A star should be a tiny point of light, not a blur. The moon should look clear and sharp. Any halo, flare, or color around an object suggests imperfection somewhere: perhaps in the diagonal; perhaps in the eyepiece. Make a good mirror, and you have little to worry about. The other two mentioned objects can be changed around much more conveniently.

Let us say again in conclusion that no one, either young or old, need be without his own telescope. Invariably enthusiasm increases with the progress of the telescope. The completion of the first one is just an incentive to go ahead with another. If there is no local amateur in your town, you can write to any of several parts-dispensers about the country who will be glad to answer your questions.[1]

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON

State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the ones submitted in the best form will be used.

LATE SOLUTIONS

1670, 4, 5. *Alan Wayne, New York, N. Y.*

1668. *Walter R. Warne, Rochester, N. Y.*

1669. *Walter R. Warne, Rochester, N. Y.; Hiram B. Sutton, Gilbert, N. Y.*

1672. *Walter R. Warne; Clayton Williams, Aurora, N. Y.*

1664. *Kenneth P. Carlson, Hershey, Nebraska.*

1676. *Proposed by Aaron Buchman, Buffalo, N. Y.*

Show that in any triangle ABC,

$$\frac{(b+c-a)\sin A}{1+\cos A}=\frac{(c+a-b)\sin B}{1+\cos B}=\frac{(a+b-c)\sin C}{1+\cos C}.$$

First Solution by Brother Felix John, Pittsburgh, Pa.

From the Law of Cosines,

$$\cos A=\frac{b^2+c^2-a^2}{2bc};\quad \cos B=\frac{a^2+c^2-b^2}{2ac};\quad \cos C=\frac{a^2+b^2-c^2}{2ab}. \tag{1}$$

Add 1 to both sides of each equation in (1),

$$1+\cos A=\frac{(a+b+c)(b+c-a)}{2bc};\quad 1+\cos B=\frac{(a+b+c)(a+c-b)}{2ac};$$
$$1+\cos C=\frac{(a+b+c)(a+b-c)}{2ab}. \tag{2}$$

Solve equations (2) for $(a+b+c)$,

$$(a+b+c)=\frac{ab(1+\cos C)}{a+b-c}=\frac{ac(1+\cos B)}{a+c-b}=\frac{bc(1+\cos A)}{b+c-a}. \tag{3}$$

From the Law of Sines,

$$\frac{c}{\sin C}=\frac{b}{\sin B}=\frac{a}{\sin A}. \tag{4}$$

Multiply (3) by (4) and invert,

$$\frac{(b+c-a)\sin A}{1+\cos A}=\frac{(a+c-b)\sin B}{1+\cos B}=\frac{(a+b-c)\sin C}{1+\cos C}. \tag{5}$$

Q.E.D.

Second Solution by the Proposer

From the formulas for the area of triangle ABC

$$r(a+b+c)=a\cdot b\cdot\sin C$$

where r is the radius of the inscribed circle.
Thus

$$r=\frac{ab\sin C}{a+b+c}$$
$$=\frac{ab(a+b-c)\sin C}{a^2+2ab+b^2-c^2}$$
$$=\frac{ab(a+b-c)\sin C}{2ab+2ab\cos C}\qquad(\text{from } c^2=a^2+b^2-2ab\cos C)$$

and

$$2r=\frac{(a+b-c)\sin C}{1+\cos C}.$$

Similarly, $$2r=\frac{(b+c-a)\sin A}{1+\cos A}=\frac{(c+a-b)\sin B}{1+\cos B}$$

and the required relation follows.

Other Solutions by George J. Ross, Brooklyn, New York; Walter R. Warne, Rochester, New York; Aaron Buchman, Buffalo, New York; David X. Gordon, Brooklyn, New York; A. MacNeish, Chicago, Illinois; Arthur Danzl, Collegeville, Minn.; Roy Wild, New Boston, Missouri; John P. Hogt, Cornwall, New York; Paul C. Overstreet, Wilmore, Kentucky, Josiah Yerkes, Brockport, New York; Alan Wayne, New York, N. Y., and A. T. Ashley, Vankleek Hill, Ont.

1677. *Proposed by John F. Wagner, Chicago, Ill.*

If, x, y, and z are not negative and if $3x/2+4y+5z/4=24$, between what integers must the expression $3x/2+5y/2+12z/5$ lie?

Solution by George J. Ross, Brooklyn, N. Y.

Let $$3x+5y/2+12z/5=K. \tag{1}$$

Combining this with (2)

$$3x/2+4y/3+5z/4=24 \text{ gives } 5y+3z=1440-30K.$$

And $30x+9z=160K-7200$, when x, and y are eliminated from (1) and (2). (4)

Since x, y, and z are not negative, the left members of (3) and (4) are not negative.

$$\therefore 1440\geqq 30K \text{ and } 160K\geqq 7200$$

$$\therefore 45\leqq K\leqq 48.$$

Solutions were also offered by David Goraon, Brooklyn, New York; Paul C. Overstreet, Wilmore, Kentucky, John F. Wagner, Chicago, Ill.; John Hoyt, Cornwall, New York; Francis L. Miksa.

1678. *Proposed by Clarence S. Warne, Romulus, N. Y.*

If a, b, c are in harmonic progression prove that

$$\left[\frac{a+b}{2a-b}+\frac{c+b}{2c-b}\right]>4.$$

Solution by Proposer

Assume $$\frac{a+b}{2a-b}+\frac{c+b}{2c-b}>4. \tag{1}$$

If a, b, c are in harmonic progression, then

$$c=\frac{ab}{2a-b}.$$

By substitution in (1) and simplifying one obtains

$$a^2+b^2>2ab. \tag{2}$$

From the fundamental relation of inequalities (2) is true. One can retrace the steps from (2) to (1) under the restrictions implied in the problem thus establishing (1).

A solution was also offered by Clayton Ernsberger, Hopkins, Minn.

1679. *Proposed by D. L. MacKay, N Y.*

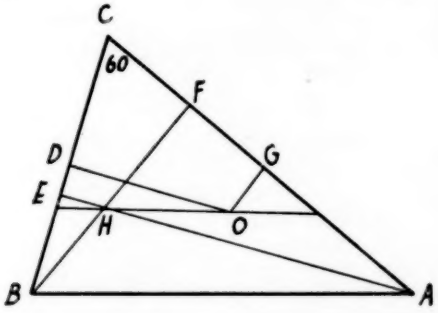
If, in triangle ABC, $C=60°$ prove that the line joining the orthocenter, and circumcenter, when produced, cuts BC at an angle of 60°.

Solution by David X. Gordon, Brooklyn, N. Y.

$$CE = AC \cos 60° = \frac{AC}{2} \qquad GC = \frac{AC}{2}$$

$$DC = \frac{BC}{2} \qquad FC = BC \cos 60° = \frac{BC}{2}$$

$$\therefore \quad DC = \frac{AC - BC}{2} \qquad \therefore \quad FG = \frac{AC - BC}{2}.$$



Since the projection of HO on BC is equal to that on AC, the angle of inclination must be 60° as the third angle of the triangle thus formed, namely angle C, is given 60°.

Solutions were also offered by A. T. Ashley, Vankleek Hill, Ont., John P. Hoyt, Cornwall, N. Y.; Paul C. Overstreet, Wilmore, Kentucky; D. F. Wallace; Walter R. Warne, Rochester, N. Y.; Bob Maas, Sheboygan, Wisconsin; George J. Ross, Brooklyn, N. Y.; Aaron Buchman; Roy Wild, New Boston, Missouri; A. MacNeish, Chicago, Ill.; and the proposer.

1680. *Proposed by Hugo Brandt, Chicago.*

A point P is given either within or without the plane of an arbitrary rectangle $ABCD$. If the lengths PA, PB and PC are equal to a, b, c respectively, what is the length of PD?

Solution by P. D. Thomas, Norman, Okla.

Let m be the line joining P to the point of intersection of the diagonals AC, BD of $ABCD$. Let $r = AC/2 = BD/2$. Then from plane geometry:

In triangle PAC $a^2 + c^2 = 2m^2 + r^2$.

In triangle PBD $b^2 + PD^2 = 2m^2 + r^2$.

Hence $\overline{PD}^2 = a^2 + c^2 - b^2$. Clearly m is the common median of triangles PAC, PBD if P is within or without the plane of $ABCD$.

Other solutions were submitted by George J. Ross, Brooklyn, N. Y.; John Hoyt, Cornwall, New York; A. MacNeish, Chicago, Illinois; Hugo Brandt, Chicago, Ill.; Paul C. Overstreet, Wilmore, Kentucky; David X. Gordon, Brooklyn, New York; Aaron Buchman, Buffalo, N. Y. Francis L. Miksa, Chicago, Ill.

1681. *Proposed by John F. Wagner, Chicago.*

Solve the equations

$$\frac{\sqrt[3]{x+y} - \sqrt[3]{x-y}}{\sqrt[3]{x+y} + \sqrt[3]{x-y}} = 3$$

$$x^2 + y^2 = 65.$$

Solution by A. MacNeish, Chicago

$$\sqrt[3]{x+y}-\sqrt[3]{x-y}=3\sqrt[3]{x+y}+3\sqrt[3]{x-y}$$
$$-2\sqrt[3]{x+y}=4\sqrt[3]{x-y}$$
$$-x-y=8x-8y$$
$$-9x = -7y$$
$$81x^2 = 49y^2$$
$$81x^2-49y^2=0$$
$$49x^2+49y^2=3185$$
$$130x^2=3185$$
$$x^2 = 24.5$$
$$x = \pm\frac{7}{2}\sqrt{2}$$
$$y = \pm\frac{9}{2}\sqrt{2}.$$

Solutions were also offered by A. T. Vankleek Hill, Ont., Joseph M. Synnerdahl, Winona, Minnesota; George J. Ross, Brooklyn, N. Y.; Margaret Joseph, Milwaukee, Wisconsin; Gilda Ebert, Mason City, Iowa; Arthur Danzl, Collegeville, Minn.; Leland Russell, McCloud, California; Vincent J. Frost, Aurora, New York; W. R. Warne, Rochester, N. Y.; Alton McLafferty, Dryden, New York; David X. Gordon, Brooklyn, New York; E. B. Escott, Oak Park, Illinois; Roy Wild, New Boston, Missouri; John F. Wagner, Lewis Institute; Paul C. Overstreet, Wilmore, Kentucky; John F. Wagner, Chicago, Illinois.

STUDENT HONOR ROLL

The editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted to this department. Teachers are urged to report to the Editor such solutions.

1679, 1680. Wendell Buckler, Harold Lipscomb, Hobert Powell, Chester Graves, from Sturgeon, Missouri.

PROBLEMS FOR SOLUTION

1693. *Proposed by John L. Wagner, Chicago, Ill.*

Find the value of

$$\frac{(4+\sqrt{15})^{3/2}+(4-\sqrt{15})^{3/2}}{(6+\sqrt{35})^{3/2}-(6-\sqrt{35})^{3/2}}.$$

1694. *Proposed by Hugo Brandt, Chicago, Ill.*

Find the smallest number x, such that $x-a$ is divisible (no remainder) by $a+1$, where a may be any one of the numbers: 1, 2, 3, 4, 5, 6, 9, 11, 13, 14, 19, 20, 27, 29, 34, 41, 59, 69, 83, 104, 139, and 209.

1695. *Proposed by John P. Hoyt, Cornwall, N. Y.*

In any triangle ABC, AD, BE and CF are lines concurrent at O in the triangle and meeting the opposite sides in points D, E, and F respectively. Prove that $AF/FB+AE/EC=AO/OD$.

1696. *Proposed by John P. Hoyt, Cornwall, N. Y.*

If n and m are any two positive integers with $n>m$ show that

$$n^m-{}_mC_1(n-1)^m+{}_mC_2(n-2)^m-\cdots(-1)^{m+1}{}_mC_m(n-m)^m=m!$$

1697. *Proposed by W. R. Warne, Rochester, N. Y.*

To construct a circle through two given points and the extremities of a diameter of a given circle.

1698. *Proposed by C. S. Warne, Romulus, N. Y.*

For any triangle prove

$$a/\sin A=\frac{a^2-b^2}{C\sin(A-B)}.$$

SCIENCE QUESTIONS

January, 1941
Conducted by Franklin T. Jones
10109 Wilbur Ave., Cleveland, Ohio

WHAT'S NEW FOR 1941?

Science teaching occupies and has occupied for many years an important and vital position in the training of young people for life—that is:—Good Citizenship which includes the ability to make money enough to support one's self and family and straight thinking which will help to avoid economic pitfalls.

Every so often we have to take an inventory of our activities to see, if possible, just where we are going.

Accordingly, this Department is asking a few questions which will, it is hoped, prompt responses and other questions which should be added to the following list:

a. Are you using science material in current magazines? (For example; *Life*, October 14, 1940, "Honey Bees," "Experiments in the Kitchen," also, *Life*, December 2, 1940, "Machine Tools.")

b. Can you find numerical problems that your pupils like to work out? (If so, send in some of them.)

c. Are the numbers studying science increasing or decreasing in your school? What is the reason? Are science teachers missing something due to the way courses are given?

d. Do the tests you give satisfy you? Do they help your pupils to study or are they attempts to compare your own teaching with the teaching in other schools?

e. What questions would you add and are the above some of the questions that ought to be answered?

ELEMENTARY SCIENCE

It has been suggested that this Department include something that goes clear back to the beginnings of science teaching in the schools. This does not mean, necessarily, what would be appropriate science material for the first grade; but has to do with subjects that the teacher can adapt to the stage of mental development of the pupils in her grade or class.

Classes and teachers are invited to contribute. Membership in the GQRA (Guild of Question Raisers and Answerers) will be granted to classes that contribute. Teachers will come in the regular category of membership.

In exceptional cases individual membership will be granted to individual Elementary Science students who make unusual contributions.

There are already 355 members in the GQRA—none of them, until this issue, from the ranks of Elementary Science classes.

What will you—the reader—contribute to our new venture?

INTEREST RAISERS IN ELEMENTARY SCIENCE

Science Questions from Boys and Girls at Doan School, Miss Anna E. Burgess, Principal, Cleveland, Ohio. (Elected to the GQRA, No. 356.)

1. Do all clouds give rain?
2. Why isn't the earth overrun with plants and animals?
3. Why don't all birds migrate?
4. Why is the beaver called one of the first conservationists?
5. If a comet's tail touches the earth could we gather any pieces from it?

Answers from other boys and girls are desired. Please send other questions. Tell how these questions were used in classes.

ELEMENTARY SCIENCE TOPICS

907. Propose a list of not more than *ten* topics that elementary science teachers find interesting.

WHY ARE THE STONES WET?

908. *Proposed by P. B. Sharpe, GQRA, No. 262. Greenwich High School, Greenwich, N. Y.*

A boy notices that sometimes on summer mornings, stones are wet while the grass is dry. He does not find much difference in different sized stones but he does find a difference between different kinds of stones. Often this condition is followed by a thunderstorm in the afternoon or evening.

Give two possible explanations.

A WAR PROBLEM

909. (Adapted)

A bomb is dropped from an airplane which is traveling horizontally at a speed of 200 miles per hour.

(a) Neglecting the effect of air resistance, how high is the plane if the bomb reaches the earth in 5 seconds?

(b) If air resistance is taken into account, will the plane have to be higher or lower than in (a)?

(c) Would this be a more sensible statement of the question from a practical point of view?

"A plane is travelling 200 miles per hour horizontally at an elevation of 5 miles above the earth. How long, neglecting air friction, will it take for a 500 pound bomb to reach the earth below?"

(If you do not like the above statements, set up a problem and send in its solution.)

(Who has some *actual* bombing problems?)

910. *What makes an automobile go?*

WHAT IS THE TROUBLE WITH 896?

896. *(Apparently the Editor pulled a "boner" on this one. What do you think about it?)*

The answer given to "Do You Know the Answers," No. 95, was—"No man has descended to a depth of four miles in the ocean: the pressure is too great." Suggested by the above—"What is the pressure due to weight of sea-water at a depth of four miles, assuming a mean density of 1.025?"

No one has yet sent in a solution, although the problem can be solved.

Comments by W. E. Harmish, Associate Professor of Education and Head of Department of Science, University of Illinois High School, Urbana, Ill. (Elected to the GQRA, No. 354.)

"I object to the use of the word density when no units are expressed. Density is defined as mass per unit of volume, and Specific Gravity as a ratio of two densities or of the masses of equal volumes.

"How can we, as teachers, defend our careless use of such terms and still insist that, in the science class-room, we teach pupils to be accurate?

"Density and Specific Gravity are two different ideas and should be held separate by teachers even if authorities in some fields of science are careless." (*Encycl. Brit.* in the article Ocean and Oceanography uses the sentence—Quote: The density of sea water is 1.925.—Vol. 19, p. 286, col. 2.)

"If the author of question 896 meant that the density was 1.025, he should state his units. If no units are stated, he should use Sp. Gr. Density is always concrete. Sp. Gr. is relative and hence has no *units*."

There is still a question. Try this problem as originally stated on some mature pupil or teacher, and ask him to "Get the answer" to the problem. Let us see what interpretation he places upon the wording and what objections he raises, if any. Is his answer numerically correct? Try it and then please report your experiences.

ANSWERS TO 898

808. *Proposed by Robert E. McKay (GQRA, No. 262), Middleport, Ohio.*

"What is the effect of pressure upon the heat of vaporization? Or, to be more direct, how does the heat of vaporization (water—538 calories per gram at 100°C.) vary with a rise or fall of the boiling point?"

Three answers were submitted, each answering the question in a different way but all arriving at the same conclusion.

Answer by J. M. Synnerdahl, St. Xavier College (GQRA No. 129.) Chicago, Ill. "Heat of vaporization decreases (according to a functional curve) as pressure increases. Boiling point is raised by an increase of pressure; hence more energy is taken up per unit mass before the elevated boiling point is reached, and, equivalently, less heat is absorbed at the belated point of vaporization."

Answer by L. C. Fender (Elected to the GQRA, No. 355), Leon Public Schools, Leon, Iowa.

In answer to Science Question No. 898, the integrated Classius-Clapeyron equation affords the easiest method for computing the relation between pressure, temperature and molal latent heat. The formula is:

$$2.303 \log \frac{p_2}{p_1} = \Delta Hm \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$$

where p_1 and p_2 are respectively the vapor pressures at the absolute temperatures T_1 and T_2. As the pressure involved appears as a ratio they may be expressed in any desired units. Similarly, ΔHm and R appear as a ratio

and must be expressed in the same unit, commonly calories. The value of R is 1.99 calories.

Over small ranges of temperatures the latent heat is practically constant.

Answer by Edwin B. Cooper (GQRA No. 254.), Brookline, Mass.

As the temperature of water increases the heat of vaporization is found to decrease until the critical temperature is reached, when it becomes zero. At the critical temperature, which for water is 374°C, a liquid and its vapor are indistinguishable and since there is no energy difference between the two states it follows that the heat of vaporization is zero.

The data below has been selected from the International Critical Tables, Volume 5, page 138:

Temperature °C	Heat of Vaporization Cal per gram
0	596
20	484
40	574
60	563
80	552
100	539
120	525
140	510
160	494
180	479

SOME QUESTIONS ABOUT MACHINE TOOLS

(Reference: *Life*, December 2, 1940)

116. Name *six* machine tools.
117. What are Hoke blocks?
118. How accurate are Hoke blocks?
119. What makes Hoke blocks stick when "wrung" together?
120. Why do airplane gears have to be so accurately ground?

Readers are invited to propose lists of questions and thus gain membership in the GQRA.

ANSWERS TO—"SOME QUESTIONS ABOUT RAILROADS"

(Taken or adapted from "Quiz on Railroads and Railroading—400 Questions" which may be obtained *free* from Association of *American Railroads*, Transportation Building, Washington, D.C.)

106. "Weights of steam locomotives vary greatly. The average weight of a freight locomotive is 144 tons; that of a passenger locomotive, 130 tons; that of a switching engine, 91 tons; that of all steam locomotives in service on the Class I railroads of the United States, 132 tons. The above weights are exclusive of tenders and are as of Dec. 31, 1938.
In 1938, the average electric locomotive on Class I railroads weighed 152 tons."
107. "The average road locomotive in service on the railroads of the United States has approximately one mile of boiler tubing."
108. "The construction of a large steam locomotive provides employment equivalent to the work of 50 men for one year."
109. "Theoretically, the contact of an absolutely perfect wheel with

an absolutely flat surface, if the materials of which the wheel and surface are made is incompressible, would be a thin line not much wider than the edge of a knife. However all structural materials deform under load. Loaded wheels resting on a rail tend to flatten the rail at the point of contact, and the tread of the rail tends to adjust itself to the curve of the wheel. Hence, the actual contact of wheel and rail is approximately the width of a chalk line."

110. "There were 29,101 passenger-carrying cars in operation on the railroads of the United States, with Pullman cars included, at the beginning of 1939. Their aggregate seating capacity was 1,738,645."

(*Auxiliary question*—If all these passengers were seated on opposite sides of a dining table, how far would they reach? Watch for the answer next month.)

GUILD OF QUESTION RAISERS AND ANSWERERS—JANUARY, 1941

354. W. E. Harmish, Associate Professor of Education and Head of Department of Science, University of Illinois High School, Urbana, Ill.

355. L. C. Fender, Leon Public Schools, Leon, Iowa.

356. Boys and Girls of Elementary Science Classes, Doan School, Cleveland, Miss Anna E. Burgess, Principal.

JOIN THE GQRA

SCIENCE EVENTS AT THE AMERICAN INSTITUTE

The American Institute Science and Engineering Clubs, in cooperation with the American Museum of Natural History, announces two outstanding events to be held in New York during the Spring of 1941. These are:

Fourth Scholastic Salon of Photography—February 15–23, 1941. Amateur ing events to be held in New York during the Spring of 1941. These are: student photographers between the ages of eleven and eighteen are invited to enter their prints for display. All work involved, including the preparation of the final print, must be done by the individual exhibitor. The previous salons have been extremely popular and have attracted entrants from every part of the country. In the 1940 Salon 378 prints of the 500 entered were selected for hanging. Prints from these salons are chosen for inclusion in the Traveling Photo Shows which are exhibited nationally during the year. Entries are due January 15, 1941.

Thirteenth Annual Science and Engineering Fair—April 27–May 4, 1941. Open to all junior and senior high school students who have outstanding experiments or demonstrations to exhibit, the Fair is an ideal place to show what has been accomplished in the construction phase of club and classroom work in science. All exhibits at the Fair must be the actual creation of student participants. Cash prizes amounting to $3,000 will be awarded for the best displays. The Science and Engineering Fair is a continuation of The American Institute's annual industrial fairs which began in 1828. Although the Fair is held in New York City, schools from every part of the United States are represented. Last year over 27,000 people visited the Fair to view 326 exhibits representing working models, experiments, live animals and plants, and technical and mechanical projects. Entries are due March 15, 1941.

THE FORTIETH ANNUAL CONVENTION OF THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS

HAROLD H. METCALF, *Secretary*
Oak Park, River Forest Township High School

SCIENCE AND THE CITIZEN was the theme of the convention of the Central Association of Science and Mathematics Teachers which was held in the Hollenden Hotel in Cleveland on Novenber 22 and 23, 1940.

Teachers who attended the convention came away saying that they had really gotten material and inspiration that would contribute to improvement in their class room instruction. The theme, Science and the Citizen, permeated the various meetings and added a practical viewpoint which is often lacking in teachers' conventions. The Cleveland Teachers cooperated fully as was shown by the fine attendance at the meetings and by the smoothness with which the mechanics of the convention were administered. All committee workers are to be congratulated on the results of their efforts but special recognition is due to the untiring work of President Nathan A. Neal. He did not lose courage as obstacles presented themselves but worked to the end of planning a program which will influence the teaching of science and mathematics in the United States.

SCHOOL SCIENCE AND MATHEMATICS will print the manuscripts of the speeches and no attempt will be made in the minutes to outline their content. Among those who appeared on the program were: Dr. T. A. Boyd, director of research, General Motors Corporation; Dr. H. T. Davis, professor of mathematics, Northwestern University; Albert Dickson Simmons naturalist and photographer; Sidney J. Williams, Director of Public Safety, National Safety Council; Dr. William W. Greulich, Director of Brush Foundation in Cleveland; Dr. George L. Bush, authority on consumer education; Dr. H. C. Christofferson, Professor of Education, Miami, University Oxford, Ohio; Dr. Earl Glenn, New Jersey State Teachers College, Montclair, N. J; Dr. Arthur B. Williams, curator, Cleveland Museum of Natural History; Dr. Paul Visscher, Western Reserve University; Dr. Amos T. Fisher, Lakewood, Ohio; Herbert W. Brandt, Director, Cleveland Bird Research Foundation; Professor John Ramseyer, Ohio State University; Dr. R. M. Sutton, Haverford College; G. P. Cahoon, Ohio State University; and Charles Stone, DePaul University.

Dr. S. R. Powers of Columbia University told of the activities of the Bureau of Research in Science Teaching at Columbia University. John C. Mayfield described the work of the National Commission on Co-operative Planning and Harold H. Metcalf explained the nature and progress of the National Committee on Science Teaching.

Special mention should be made of the innovation of the Conservation Committee and the Geography Section cooperating in holding a luncheon at noon on Friday. Over 100 attended to eat together and to hear discussions on phases of the conservation problem.

The pupils who cooperated to make the banquet a success received much praise. The singing by the Octette, the Russian dances, Dorothy Masek and her accordion, and the Cleveland Heights A Capella Choir were all greatly enjoyed. The paper delivered by Sidney J. Williams on "Science Mathematics, and Safety" will appear in full in an early issue of the Journal.

THE SATURDAY MORNING BUSINESS SESSION

President Nathan A. Neal presided.

Mrs. Wilcox moved, Mr. Leonard seconded and it was passed that the minutes be dispensed with.

Mr. Roecker, business manager of the Journal, reported that the Association was in a financial position to pay all bills and to operate the coming year.

Dr. Potzer reported that the Yearbook would turn approximately $200 over to the Association. He reported fine cooperation on the part of the exhibitors.

Mr. Soliday's membership report is printed in full.

Mr. A. O. Baker reported informally for the Conservation Committee. A full report of the fine work of this committee will appear in a later issue of the Journal.

Dr. Christofferson reported for the Cooperation Committee. They recommended a meeting to be held in March and sponsored by the Central Association and other cooperating associations to study the implications of the present world emergency for science and mathematics teachers. The Board of Directors later voted to further study this recommendation.

Mr. Carnahan, Chairman of the Curriculum Committee, described a paper panel which the Committee had conducted and the results of which will be submitted for publication in the Journal.

Mr. Gingery reported for the Journal Committee. The funds of the Journal are greater than ever before. A slight trend toward fewer subscribers to the Journal and toward less advertising revenue is being further studied by the Committee.

Mr. Frey reported for the Journal Display Committee. 104 registered and $4 worth of reprints were sold. Dr. Price's dental exhibit was educational and attracted many people.

The report of the Necrology Committee appears in full.

Mr. Hanske, Chairman of the Place of Meeting Committee, reported that the Committee recommended Chicago as the next city for the convention. The Board of Directors later accepted this recommendation.

The report of the Resolutions Committee appears in full.

Mr. Carnahan offered a resolution to the effect that the work of the Curriculum Committee was complete and therefore the Committee should be discontinued. The Board of Directors later accepted this recommendation.

Mr. Bemisderfer, Chairman of the Nominations Committee, presented the following report: The Committee recommends the following officers for the Central Association of Science and Mathematics Teachers for 1940–41.

For president, Harold H. Metcalf, Oak Park, River Forest High School Oak Park, Ill.

For vice-pres.; Franklin Frey, Waukegan Township High School, Waukegan Ill.

For directors to serve three years.

C. F. Hanske, Emmerich Manual Tr. H. S. Indianapolis, Indiana.
A. O. Baker, Marshall High School, Cleveland, Ohio.
Glenn F. Hewitt, Von Steuben H. S., Chicago, Ill.
E. L. Massey, Science Supervisor, Detroit, Michigan.

For director to serve one year in place of Franklin Frey,

J. J. Urbancek, Chicago Teachers College, Chicago, Ill.

Mr. Bemisderfer moved, it was seconded and carried that the officers recommended by the Nominating Committee be elected by acclamation.

The Board of Directors later voted that Ray C. Soliday of the Oak Park, River Forest Township High School become Secretary.

REPORT OF THE NECROLOGY COMMITTEE

Mr. R. E. Davis, chemistry teacher at Lane Tech. High School in Chicago, died last spring after a brief illness. Mr. Davis was active in the Chi-

cago section of the American Chemical Society, and was an active member of the Central Association of Science and Mathematics Teachers for many years.

Mr. Thomas R. Moyle, chemistry teacher at Boys' Tech. High School at Milwaukee, Wisconsin, died this fall after an entire summer's illness during which time he was at the Veterans' Hospital. Mr. Moyle had taught at Boys' Tech for twenty one years and had been a member of the Central Association for many years.

L. H. TROUTMAN, CHAIRMAN

REPORT OF PLACE OF MEETING COMMITTEE

The Place of Meeting Committee has received petitions from Chicago and Milwaukee. Since it has been the policy of the organization to always return to Chicago, the Committee recommends Chicago as the meeting place in 1941. Because Milwaukee has made a strong plea for the convention, we recommend that the '41 Committee consider Milwaukee very carefully for the 1942 convention.

PAULINE ROYT
ALMA THOMAS
BERTHA OESCHSLE
CARL F. HANSKE, *Chairman*

REPORT OF THE RESOLUTIONS COMMITTEE

The resolutions committee wishes to present to the members and the Board of Directors of the Central Association of Science and Mathematics Teachers the following resolutions for their consideration:

1. Resolved, that the Board of Directors consider the advisability of discontinuing the geography section and that a new section be substituted with greater prospects for growth.
2. Resolved, that the policy of introducing a twelve year science program in all schools be reaffirmed and that the President either appoint or delegate a committee already in existence to help put this policy into effect.
3. Resolved, that a closer relation be established between science, mathematics, and social studies.
4. Resolved, that this association cooperate with the program of national defense in science and mathematics instruction.

EMIL A. MASSEY, Detroit
M. J. W. PHILLIPS, West Allis
W. F. ROECKER, Milwaukee
ERNEST O. BOWER, Cleveland, *Chairman*

REPORT OF THE MEMBERSHIP COMMITTEE

Activities of the Membership Committee have continued similarly to those of the last several years. Our goal has been to inform teachers of the advantages of membership in our Association, with emphasis placed largely upon the Convention program and the Journal. Convention programs, Yearbooks, and sample copies of the Journal were distributed at teacher's meetings and by mail to schools and individual teachers. Considerable attention was devoted to reaching teachers in private and parochial schools.

We have sought to serve both the Association and younger teachers by inviting student-teachers to attend our Convention as guests of the Association.

Our committee now has, for the first time, complete records of the actual membership. This information will contribute greatly to the efficiency of membership activities.

The committee this year includes two new workers, Mr. Emil Massey, supervisor of science in Detroit, and Mr. F. W. Moody, of the Cleveland High School in St. Louis. The membership work in the convention city was handled this year by Miss Alma Thomas, of the Marshall High School in Cleveland.

The members of this committee are enthusiastic about their work, and are constantly striving toward definite improvement in methods and results. It is hoped that the committee of next year can more effectively use the materials available and can materially increase the membership and attendance at the convention in Chicago. Suggestions for improvement from other members of the Association are always welcome.

RAY C. SOLIDAY, *Chairman*

BIOLOGY SECTION

Presiding: Al G. Grosche

(Joint meeting with the Greater Cleveland Biology Society)

Dr. Arthur B. Williams, Curator of Education in the Cleveland Museum of Natural History, was the first speaker. His topic was, "Park Areas as Teaching Assets in Biology." Dr. Williams emphasized the fact that one can find an outdoor laboratory for the study of biology anywhere that there is a bit of native vegetation. He illustrated the possibilities of park areas as outdoor laboratories by describing the Cleveland Parks and what is being done with them by the Museum staff and by the schools in the Cleveland area. Use of the opportunities is on the increase.

With a series of beautiful slides Dr. Williams then showed that park areas could be used in connection with the teaching of such topics as the following: geology—soil formation, structure of the earth, fossils; trees—habitat, succession, identification and characteristics of different kinds; other plant groups—wild flowers, ferns, fungi; growth; animals—birds and bird migration, mammals, reptiles, amphibians, insects, snails. He told of the success of the nature trails and the bird walks that have been arranged in the Cleveland Parks. The teachers present were inspired to attempt more use of local outdoor facilities in teaching biology even though there are many practical difficulties in the way.

Dr. J. Paul Visscher, of the Biological Laboratory of Western Reserve University, pointed out that biology teachers teach too much from books and dead material. One of the problems is to find a source of living material suitable for instruction. He showed that the fresh-water life of most regions provides a source of abundant and varied living material that can be effectively used in teaching biology. The use of microscopes is important in the study of such life, but this is appropriate because half of the living world is revealed only by this instrument. However, if necessary, microprojection may be used effectively and students may be interested in constructing their own microprojectors.

The use of freshwater plants and animals opens an entirely new world to the average pupil and he is intrigued by a consideration of the differences between living in water and living in air. Aquatic life also provides effective illustrations of the interdependence of living things and of the balance that they attain. Through the study of fresh-water biology, interest is stimulated and concepts are developed that will lead to a more constructive attitude toward conservation.

Miss Nell Henry, of Glenville High School, introduced members of the Greater Cleveland Biology Society who have assisted in developing special aspects of biology study in the city. Mr. Ellis C. Persing, of West Technical High School, told how the Cleveland Natural Science Club has developed a group of members who keep a nature trail up-to-date, another that main-

tains a museum of the things that can be seen outdoors in the Cleveland area, and still a third group that is active in the use of photography for recording natural phenomena and making the records available to teachers. Mr. Persing described the Lodge built by the club and invited all members of the section to visit the lodge on Saturday.

Miss Eugenia Couden, of James Ford Rhodes High School, outlined a method by which she has introduced an effective study of first aid into her biology classes after they have a foundational knowledge of human physiology. Mr. E. D. Collings, of John Marshall High School, described the use of the rotary system of scheduling and teaching biology classes and pointed out some of the advantages it gives.

The exhibitors' part of the program was taken by Mr. Clem Brooke, of the Denoyer-Geppert Company, who described the historical attempts that have been made to study the shapes and location of spaces in biological specimens. He described the most modern method of preparing casts of the insides of cavities such as those of the kidney by injecting them with dissolved plastics and latex injection fluid after which the tissues are removed by chemical treatment.

Sixty persons attended the meeting. The officers elected for the coming year are: Chairman—Joseph W. Rhodes, Senior High School, Beloit, Wisconsin; Vice-Chairman—John C. Mayfield, University of Chicago; Secretary—Sarah C. Caldwell, High School, Akron, Ohio.

JOHN C. MAYFIELD, *Secretary*

CHEMISTRY SECTION

Presiding: R. C. Soliday

"The Motor Car's Debt to Chemistry"—Dr. T. A. Boyd

Many of the contributions to the automotive industries came from chemistry, either as direct or as indirect contributions.

Modern research has had much to do with the quality and price of modern car. A car of today costs one-third as much as a car of 1920.

The factors which have made the modern car possible are: (1) synthetic finishes, (2) tires, (3) alloy-steels, (4) gasoline. The development of all of these factors has depended upon chemistry.

In the development of tires, the process of vulcanization was the most important contribution. Other contributions have been: (1) organic accelerators to cut the time of vulcanization, (2) finding the value of a high percentage of carbon black to increase the life of rubber, and to make rubber useful in other things than tires. There are 250 uses for rubber in the modern car. The bonding of rubber to steel is another important contribution.

Synthetic rubbers may find greater uses in the future. Tires may become, through the use of synthetic rubber, a true product of chemistry, and, when this becomes true, the United States will be free from the need of importing rubber.

Of the alloy-steels made, 50 per cent go into the car industry, and most of the other 50 per cent go into the petroleum industry.

The properties of a good fuel for automobiles are: (1) plentiful, (2) cheap, (3) ease of vaporization, (4) high content of energy, (5) freedom from knock.

Chemistry has made very definite contributions to all of these, especially to the ease of vaporization and the freedom from knock. Gasolines which are free from knock are produced by making a shorter carbon chain which can be done by cracking or by polymerization. The polymerization of gasolines, like eso-octane, is the greatest chemical advance in the last decade. Other contributions to the elimination of knock have been in the

production of tetra-ethyl lead and the bromine industry. The number of research workers in the petroleum industry has doubled in the past decade.

Every element in the automobile except the wood and water is a product of chemistry. Three thousand chemists employed in 250 research laboratories contribute directly to automobile research.

The future research needs to discover the chemistry of the combustion which takes place within the engine of a car.

As teachers, we need to prepare pupils to be able to: (1) find new knowledge, i.e., to know how to go about finding new knowledge, (2) to know the fundamentals of chemistry and to know how this knowledge is universally used, (3) to be able to use the scientific method.

Officers elected for next year are: Sherman Wilson, Detroit, Chairman; F. C. Chiddix, Normal, Ill., Vice-Chairman and W. R. Woline, Shortridge High School, Indianapolis, Secretary.

Round Table Discussion—V. C. Culp, Leader.

Mr. Holder: Students must learn to use scientific facts and the scientific method in the solution of modern problems. The course of study should be re-organized to develop these outcomes, which means that emphasis must be placed upon factual knowledge. Keep chemistry based upon truths as observed.

There is a need for more science in elementary grades. We attempt to teach too much chemistry in the time allowed. In teaching less chemistry, it must be kept scientific.

Mr. McCormick: The program of science needs to be adjusted to the increased personnel from the lower social-economic levels. Only one-fifth of our pupils enter college, but all pupils are consumers. Therefore, we need to teach consumer chemistry to meet the need of all of these pupils. The relationship between chemistry and living is the only basis for the inclusion of it in the curriculum.

The material for science courses is to be found in the environment, i.e., in the way that science affects the life of the individual. Science instruction that does not function in the life of the individual is of no value. Instruction should contribute to intelligent consumership. It should create an awareness of technical knowledge needed to analyze advertising and commercial products, and not to make chemists.

Mr. Baker: Pupils need a comprehension of fundamental principles and the ability to apply them. Science teaching should extend from the kindergarten to the college. In this is needed a two year course covering the fundamental principles of physical and biological sciences, based upon the natural interests of the pupils. These two years should be placed somewhere from grades 9–10. This will tend to move a knowledge of these fundamentals into the earlier years of the individual's life.

We should diverge from individual courses into courses which include these related fundamentals which all pupils should have.

People do not need to understand principles to be able to use them. We should bring into use the shop parlance, as well as the technical terms.

Introductory science needs to be decompartmentalized and modernized. It should be an adequate survey course based upon fundamental principles with emphasis upon use of these principles. Tie in the reason for happening with the "Why?"

CURTIS M. HOWD, *Secretary Pro tem.*

ELEMENTARY SCIENCE SECTION

In the absence of the chairman, Dr. W. C. Croxton, the meeting of the Elementary Science section was conducted by the Vice-Chairman, Miss Mary Melrose.

The minutes of the meeting held in Chicago were read and approved. Following the reading of the minutes, we proceeded at once to the excellent program. Every speaker made a definite contribution to the classroom teacher.

Miss Eleanor V. Liddle, from Sheridan School in Youngstown, Ohio, read a paper describing a very comprehensive science unit for sixth grade, "How Science Helps Progress." By means of experimentation, reading, excursions, supplemented with talks by members of the community, the pupils traced the contributions of science to modern transportation, communication, health, and industry.

The Science Club of Memphis School, Cleveland, under the leadership of Miss Mildred Pelikan, delighted the audience with demonstrations of their musical instruments which they had been stimulated to make by their study of sound. They also repeated a program which their club had broadcasted over the Board of Education radio station WBOE. There was no doubt in the minds of the audience that the children had mastered thoroughly the basic understandings in the elementary science unit "What Causes Sound?"

"Community Resources and Elementary Science" was the subject of Mr. Earl Studt's talk. Mr. Studt, the Supervisor of Elementary Science in the Lincoln Training School at Ypsilanti, Michigan, described for us the setting of his school, an ideal one for the first-hand study of plants and animals. "But," he went on to say, "it is not the natural environment alone which vitalizes our science teaching. We also make extensive use of our human-related resources, persons in the community with special interests in science."

Mr. Studt then briefly described a unit on the improvement of one corner of their school grounds, a project carried on by the pupils themselves. This portion of the talk was illustrated by slides.

Miss Dora Wood, a teacher at Hayes School in Lakewood, Ohio, gave an excellent exposition of the value of field trips as an essential part of science units. Illustrating her talk with slides and with sample copies of pupil guide sheets for a geology trip. Miss Wood explained clearly how she plans, carries out, and follows up science field trips.

The report of the nominating committee was then presented by the secretary pro tem., and adopted unanimously by the group. The officers for 1941 are as follows:

Chairman—Miss Mary Melrose, Supervisor of Elementary Science, Cleveland, Ohio.

Vice-Chairman—Dr. Paul E. Kambly, Head of Science Department, University Experimental School, Iowa State University, Iowa City.

Secretary—Miss Anna E. Burgess, Principal Doan School, Elementary Science Curriculum Center, Cleveland, Ohio.

The meeging was then turned over to Mr. D. L. Barr, who, under the sponsorship of the W. M. Welch Co., presented a talk on "Elementary Science Equipment."

ANNA E. BURGESS, *Secretary Pro tem.*

GENERAL SCIENCE SECTION

The meeting of the General Science Section was called to order by the chairman R. Emerson Park of Oak Park, Illinois. The nominating committee was instructed to give its report. It was moved, seconded, and adopted that Donald B. Pettit of the University of Iowa be Chairman, Joseph Dickman of Chicago be Vice Chairman, and H. A. Oetting of Wood River, Illinois be Secretary for the coming year.

Dr. Wilbur L. Beauchamp of the University of Chicago delivered the first address on the topic, "Teaching Patterns in General Science." He started his talk by stressing that in a teaching plan objectives should be functional.

First, there should be a stimulus which will result in thinking. This stimulus should be some problem related either to the pupil's past experience, or to something he is familiar with. It may be a demonstration, or an experience that will raise a problem. This problem should be stated by the pupil himself. To best "set the stage," start with material at the student's level and then work backward to the scientific principle underlying it. For example, in teaching the unit on oxygen, the teacher might start by asking the students how they would build a fire. They would probably answer that a fire could be started by setting a match to some small pieces of paper or wood. Two simple scientific facts can be gathered from this question,—(1)there is need for oxygen to unite with the small bits of material and, (2) the paper has a low kindling point. There may be many problems pertaining to one general principle. The teacher should start with common experience and drive to the point where the pupil can no longer answer his "Why?" Have problems written on the board. If demonstration is at all possible, the pupil will then be able to see the real problem, perhaps getting his answers through, "What does this thing do?" Thinking can only be done by the pupil if the material is at his own level.

The second step in the teaching plan is to provide opportunities for the assimilation of material which will result in the solution of the problem. These may be a field trip, experiments performed, demonstrations, etc. At this point it is very necessary for the teacher to keep the pupil thinking. His observations should not be passive. If the demonstration is used, the pupil should have in mind the problem and the general steps,—then he should be made to anticipate the results by asking him, "What do you think will happen?" He should have in mind what he is looking for,—thus real thinking may be provoked in his trying to verify his opinion. There may be some implications in the results. Pupils may find that they need a control experiment in order to be able to come to any real conclusion. Students should make their own observations. Under no conditions should a teacher in doing a demonstration, tell what he has set up, what he is doing, and what is happening. Have each pupil write his own observations and his own conclusions. In looking over some of these conclusions the teacher may have two or three different ones put on the board. These he could consider as hypotheses, if needed for further reasoning.

At this step in the lesson development may come a critical point. The teacher who feels pressed for time will tear right on to new facts,—but here he should stop. See that the pupil catches the point,—that he is doing real thinking,—but also see that he notes the relations between this and other things involved. This is the point of apprehension, or the third step.

The third step in the teaching plan is to make this principle have meaning. Dewey states that the pupil is to grasp the meaning in relation to other things. Make the principle function by asking how it may be otherwise used. Also, teach the pupils how to tear apart a principle. Analyze it for cause and effect. When certain things are present a definite effect will take place. Show that to know the conditions means that you will know the effect. By transferring the principle into many everyday applications the pupil may be led to a better understanding of both the principle and other connected generalizations.

The fourth step in the teaching plan is reaction. The pupil must be given plenty of opportunity to explain. A child has much difficulty in seeing science terms as a part of his environment. A pupil may be asked what

happens to the water level of a ship when it enters salt water, and see the situation only as one interesting fact of his environment. If after asking this question, some simple scientific questions connected with it are also asked, the pupil may be led to understand an important scientific principle in terms of this particular environment. He *Accepts the Principle*, for there has been a transfer of the idea, and a level of understanding has been reached.

We were indeed very fortunate in having Mr. C. G. Andrus of the Cleveland Airport to take the place of Mr. B. C. Haynes who was unable to be present. Mr. Andrus took the same topic, namely, "Introduction of Recent Developments in Meteorology into General Science."

Mr. B. C. Haynes will soon have a government publication ready for use. Mr. Andrus thought that the bulletin number would be twenty-five. It is not on sale as yet. This will be on Meteorology and will be a book in the Pilot Training Series. Mr. Haynes has been teaching a course to the meteorologists of the country. From the part Mr. Andrus presented it seems as if every general science teacher should make this book a part of his teaching equipment.

Mr. Andrus told us about the theory of the Norwegian meteorologist Bjerknes. This theory may be quite applicable in Europe, but it cannot be accepted without modifications for the United States.

The polar-front theory is an old theory but it has new applications. Mr. Andrus compared the cold mass to the well know "ad" of the world with a pot of paint dumped on it. He said that the cold mass splashes in just such daubs; that the masses of cold air separate from the whole in just such splashes and undercut the warm air strata. The difficulty of weather forecasting is the knowledge of where we are in relation to these masses. The basis, then, of the solution of problems in meteorology is the new air mass analysis method.

The polar-front theory, he says, is the key to the problem of weather. The problems cannot be completely solved because they are so intricate. The problems involved in weather are not simple, because there are so many variables. We might wait twenty years for a repetition of a phenomena and even then one never knows when nor where it will occur. It is necessary to make assumptions in the solution of many science problems, but with meterologist's problems the assumptions probably are not so good and therefore the conclusions may not be as correct as the conclusions in other fields of science using same number of assumptions.

Many teachers do not make use of things already known such as statistical report given in climatological data. Pupils should realize the value of this data in the commercial field today. A steam company contracting for the heating of a building could not do this without data kept by the Weather Bureau. A concept which teachers fail to have their pupils conceive is that they live at the bottom of an ocean of air.

The key has not been found to many of the problems in meteorology, for example, "How is rain formed?" Man has not been able to produce rain. Is the crystal basic in the formation of rain? Probably the crystal must form first and then melt in order to form rain.

Not to discourage us, Mr. Andrus said that much is known of the atmosphere today because of the air mass data obtained through the use of sound balloons with radio equipment that pierce the atmosphere to 50,000 feet. We need to know more of the third dimension of the atmosphere.

There is a tremendous new field in observation. Probably we need amateur meteorologists to collect valuable data as we have the amateur astronomer. The air chilling process is somewhat understood today, but not well enough.

Controlling weather may not be possible but applied meteorology will mean that we can be prepared for what comes. We live in this ocean of air all the time therefore we should know about it. There is much more known about it today than twenty years ago.

In order to understand about weather we must know all about physical mixtures—that is—the properties of fluids or gases. We must know all about the variability of the water vapor, and the forms we may find it in such as liquid, gas, crystals or solid. Water is a tremendous factor in weather. We could understand something about it if we had a thorough knowledge of hydrology as the result of the study of the ocean.

Physics is very important in the study of weather. Weather is very complicated because of moisture and temperature. Dust does not enter into the problem very much although there is a common misconception that it does. Children should always be aware of the need of a very watchful eye in this moving thing—weather. The application of meteorology has two phases: first, forecasting, the analysis of which is most fascinating to people today; second, statistical meteorology or climatology; and probably a third, the airplane trails at an altitude of 15,000 feet.

Meteorology is a very young science. There is much superstition and misbelief about it today. For us in this region it is a study of the movement of cold and non-cold or warm air masses. There are no tropical air masses drifting into our area except in rare cases.

In the absence of the secretary these addresses are reported by Pauline Royt and Frances Mandelzweig.

The third speaker on the program was Dr. Amos T. Fisher a physician and surgeon of Lakewood, Ohio. His topic, "Intravenous Medication as a Treatment For Disease" was also in keeping with the Convention Theme, "Science and the Citizen."

Dr. Fisher first told how he got the idea of the varied possibilities for curing diseases through intravenous treatments. During the years from 1913 to 1916 he had charge of some special medical work in a large state hospital for the insane. As a part of his laboratory work in that hospital it was his duty to treat the syphilitic patients intravenously. There he had the opportunity to try mild solutions of a great number of medicines in determining their blood reactions and thus their curative effects. At that time he had to make up his own solutions. Now their values are so well recognized that they can be obtained from several pharmaceutical manufacturers without delay. These firms list many remedies manufactured expressly for intravenous use and give instructions concerning indications and contraindications for their use; and they also list explanations concerning proper technique and the dangers of poor technique.

Dr. Fisher emphasized the many advantages derived from the intravenous method, particularly for certain types of diseases. He pointed out how the blood combats disease, and how certain solutions make the blood react so that it more rapidly throws off the ailment. Cautions on administering treatment were given, and what could be expected if the injections went into tissue instead of directly into the blood stream.

Many other interesting facts concernings treatments were given but they will not be mentioned in this summary. Dr. Fisher's complete address will appear in a later issue of THE JOURNAL.

GEOGRAPHY SECTION

The luncheon meeting of the Geography Section, sponsored by the Conservation Committee, Arthur O. Baker, Chairman, was held in the Rendezvous Room of the Hollenden, Friday noon, November 22. One hundred members and friends attended. Mrs. Katharine W. Isenbarger, Chairman

of the Geography Section, presided, introducing guests of honor and Mr. Baker, who introduced the guest speakers.

Mr. C. M. Shipman of Cleveland, presented problems of conservation, using lantern slides. His views of typical Ohio trees and woodlands showed the part such vegetation plays in the formation of soil, in soil conservation, and in flood and erosion control.

Mr. Albert Dickson Simmons, author of "Wing Shots," and Nature Series broadcaster over radio station WTAM, brought the outdoors indoors with his lantern slides and films in natural color. His pictorial record of waterfowl, secured in the Sandusky Marshes shortly before the opening of the hunting season, revealed bird flight as nothing else could. Mr. Simmons urged the more general use of natural color photography, a new and interesting tool, bound to lead to a keener appreciation of nature.

At the business meeting, the following officers were elected: Miss Villa B. Smith, John Hay High School, Cleveland, Chairman; Mrs. Viva T. Martin, Arsenal Technical High School, Indianapolis, Vice Chairman; Mr. F. J. Breeze, North Side High School, Fort Wayne, Secretary.

It was voted to co-operate with the Conservation Committee another year; plans for a luncheon meeting to be worked out jointly.

VILLA B. SMITH, *Secretary, Pro tem.*

MATHEMATICS SECTION

The mathematics section was called to order by its chairman, Mr. F. W. Runge of Evanston Township H. S., in the Cypress Room of the Hollenden Hotel, Cleveland, Ohio, at 2:00 P. M., November 22, 1940. The convention theme was "Science and the Citizen."

Miss Mary A. Potter of Racine, Wisconsin was the first speaker. As president of the National Council of Teachers of Mathematics she extended "Greetings" to this Section. She voiced the happy thought that the clouds under which secondary mathematics has for some time been, seemed to be beginning to break as indicated by recommendations from a sub-committee of the War Preparedness Committee, that all competent secondary school students should take all the mathematics offered in their schools in order to meet the military needs of the country. She also outlined the report of the Joint Commission on The Place of Mathematics in Secondary Schools.

Words of "Greeting" were also given by Dr. H. E. Grime, Supervisor of Mathematics in Cleveland.

Dr. H. T. Davis of Northwestern University carried the convention theme to the section by his talk on "Mathematics and the Social Sciences." He maintained that applications of mathematics should not be limited to the physical sciences but should be drawn also from the social studies. More use should be made of equations and formulas used in economics, of the supply and demand curves, of problems dealing with budgets, of probability, etc.

The next speaker was Prof. John A. Ramseyer of University School, College of Education, Ohio State University, whose topic was "Mathematics and the Consumer." He discussed the social factors that need analysis when a consumer problem is attacked, factors such as change, rate of change, hidden costs, dependence, trends, expectancy, sampling, and value. He reduced these social factors to three mathematical concepts, (1) reduction of any magnitude to quantitative terms, (2) dependence, (3) the principle of underlying assumptions. His work for 11th and 12th grades has been organized around five different concepts, namely, planned spending, credit plans, installment buying, cooperative problems, and selling problems.

A Panel Discussion on "Mathematics and the Citizen" followed with

Dr. Stone of De Paul University, Chicago, leading. Prof. Leroy H. Schnell of State Teachers' College, Indiana, Penn., spoke on "Training for Citizenship." He stressed the importance of learning to look for causes which lie back of mathematical data, since, he said, situations are less frequent in the lives of the average person where computation is necessary than where there is need for analyzing and interpreting the situation. Dr. Overn of Du Sable High School, Chicago, was the next participant in the panel discussion. He considered three aspects of mathematics involved in the life of the citizen, namely, computation, comparison, and deduction, Then followed Mr. A. E. Downer of Cass Technical High School, Detroit, with a talk on the "Use of Mathematics in Aeronautics." He stressed the importance of labelling results in proper units, of ability to interpret graphs, of ability to work with formulas, and of drill in the fundamentals of arithmetic. Dr. Stone then took charge of the discussion carrying the program over into The Exhibitors' Program with a talk on "The Slide Rule and The Army." He had diagrams with trigonometric formulas to show the problems which lead to the artillerymen's use of the slide rule when he is spotting a target.

On the Exhibitors' Program also was Dr. Carl N. Schuster of State Teachers' College, Trenton, N. J., who spoke on "Adding Interest to Mathematics Through the Use of Instruments." He had many interesting exhibits of Field work in Mathematics.

The nominating committee for the Mathematics Section was composed of Mr. Edwin W. Schreiber, State Teachers' College, Macomb, Ill., chairman; Miss Ona Kraft, East H. S., Cleveland; and Mr. Hans Gutekunst, Batavia H. S., Ill. The officers for next year are: Chairman, Dr. H. G. Ayre, State Teachers' College, Macomb, Illinois; Vice-Chairman, Agnes MacNeish, Tilden Technical High School, Chicago; and Secretary, Mr. Joe Kettery, Arsenal Technical H. S., Indianapolis, Indiana.

AGNES MACNEISH, *Secretary*

PHYSICS SECTION

The Physics Section was called to order by Vice Chairman George E. O. Peterson, Schurz High School, Chicago, Illinois.

Dr. R. M. Sutton, Professor of Physics, Haverford College presented a demonstration lecture entitled, "Rescuing Physics from the Text Books."

This was an exceedingly interesting and enlightening discourse in which Dr. Sutton presented many interesting demonstrations with inexpensive apparatus which not only made the principles he discussed quite evident but created a desire among the physics teachers of the audience to go back to their classes and make physics more dynamic by presenting these and other demonstrations to their students.

Not only were the demonstrations well selected and adapted to high school students level but they were well executed and presented through the master showmanship of Dr. Sutton.

Watch for a full account of these demonstrations and the lecture in the JOURNAL.

Officers elected for next year were: Chairman, George E. O. Peterson, Schurz High School, Chicago; Vice Chairman, E. O. Bower, East Technical High School, Cleveland, Ohio; Secretary, P. A. Tapley, Tilden Technical High School, Chicago, Ill.

"The New Physics"

The second speaker, Dr. Robert S. Shankland, Head of the Physics Department, Case School of Applied Science, Cleveland, Ohio, chose for his subject, "The New Physics."

Dr. Shankland gave a very enlightening discussion of the new physical principles that are being discovered and developed in the research laboratories of our colleges and universities. The lecture was presented in conjunction with well prepared slides which showed pictures of the apparatus used and line drawings which aided in explaining the physical principles under discussion. Not only were the new discoveries and developments presented in a vivid manner but many of their practical and potential uses were discussed.

The part that physics and physicists play in our National defense was also discussed in a general way.

A detailed discussion of this lecture will be presented in a JOURNAL issue.

"High School Physics in General Education"

This was the subject selected by Mr. Kenneth E. Vordenberg, Washington High School, Cincinnati, Ohio.

The discussion was based upon the work done this summer and fall by the Committee on Physics Teaching of which Mr. Vordenberg was a member.

It was an excellent report consisting of the status of physics in high schools, the reasons for this condition, and suggested remedies that may be applied to secure more and better physics instruction in secondary schools.

Since the work delegated to this committee requires more time to complete it, the same committee was appointed to continue for another year.

For a detailed description of the work of this Committee see a later issue of the JOURNAL.

Round Table Discussion

Ray Lambert, Walnut Hills High School, Cincinnati led a very interesting Round Table Discussion in which the status of high school physics instruction was presented and how the physics instruction may be improved so that it will reach more high school students.

Many members took part in this discussion and offered suggestions which they thought would aid physics instruction in secondary schools and thus reach more students.

Among the suggestions to better physics instruction was to fit the instruction more closely to the lives and needs of the pupils, and to make it more interesting by presenting the material in a dynamic way.

ERNEST O. BOWER, *Secretary*

ELEMENTARY SCIENCE GROUP MEETING

The Saturday meeting of the Elementary Science section consisted of a round table discussion of questions submitted before and during the meeting.

Members of the panel represented different types of educational experience:

Chairman—Dr. G. P. Cahoon, College of Education, Ohio State University.

Members—

Dr. Paul E. Kambly, Head of Science Department, University Experimental School, Iowa State University, Iowa City.

Mr. H. M. Buckley, Assistant Superintendent, in charge of elementary schools, Cleveland, Ohio.

Mrs. Ethel K. Howard, General Supervisor, Lakewood, Ohio.

Dr. David W. Russell, National College of Education, Evanston, Ill.

Mr. W. L. Shuman, Assistant Superintendent, Cuyahoga County Schools, Cleveland, Ohio.

Miss Anna E. Burgess, Principal, Doan School, Cleveland, Ohio.

Some of the questions discussed were:

How can teachers in service become better teachers of elementary science?

What are some of the most common subject matter errors made by elementary science teachers?

What are some specific activities and experiences in science which should be provided for elementary children?

What are the criteria of a good elementary science unit?

How can science in the elementary grades contribute to the development of thinking?

The fact that several small groups continued the discussion of questions after the meeting was adjourned, was indicative that the problems were vital to many of the audience.

ANNA E. BURGESS, *Secretary, Pro tem.*

JUNIOR HIGH SCHOOL GROUP MEETING

The meeting of the Junior High School Group was called to order by the chairman Ellis C. Persing of Cleveland, Ohio. He introduced the first speaker, James L. Russell, who is a lawyer but has astronomy as a hobby. He spoke on "Introducing Telescope Making to the Schools." Mr. Russell gave a very elementary talk on telescope making, thus attracting those inexperienced in the field. He explained the essential parts of a reflector telescope and told about the steps in its construction. His speciality is the reflector telescope of very short focal length that does not need a mounting but can be held in the arms during observation. This type he called the "baby telescope." The focal length of the concave mirror is but thirty-six inches. The tube is made of cardboard thus making the instrument very light in weight. He brought two types of reflector telescopes that his club members make, namely, the Newtonian and the Cassegranian. He discouraged the construction of the Cassegranian for the beginner because the reflecting small mirror at the top of the tube was rather difficult to make because this small mirror must be convex. The cutting of the hole in the reflecting mirror of the Cassegranian telescope was, however, a relatively simple task. Mr. Russell gave mimeographed copies of instructions on the making of the telescope. He estimated the cost of these "scopes" between five and twenty dollars.

All teachers and particularly Junior High School teachers were very much interested and concerned about Dr. H. C. Christofferson's topic on "The Crucial Place of Junior High School Mathematics in Education for Competency." Dr. Christofferson said that, because mathematics had so many rules, many teachers taught only the mechanics of mathematics and had the pupils work the examples like the sample given. He granted that the skills might be useful in themselves but that only skill with understanding was education. It is probable that Dr. Christofferson's paper will appear in the JOURNAL at a later date, so a complete report will not be given here.

The next topic, "Experimental Science for the Citizen" given by Dr. Earl Glenn of the New Jersey State Teachers College was indeed a very timely one since it was a sequence to D. B. Pettit's topic given last year and which appeared in the JOURNAL late this year. Dr. Glenn revealed many startling facts regarding the experiments in the text books that we are using. It is hoped that he might condense and publish the results of his findings in our JOURNAL. A few items that he brought out in studying

fifteen popularly used three-book series are as follows: Twelve books have 60% of the experiments in the first semester; eleven books have 50% of the experiments in the field of physics; two books have 50% of the experiments in biology; one book has 50% of the experiments in chemistry; and one book has 50% of the experiments in astronomy. There was a total of 868 experiments in all of the fifteen books. No one experiment appeared in all of the books; 42% of the 868 experiments were used only in one book; and only forty-five experiments appeared in two or more books. Dr. Glenn felt that the publishers should require the author to teach his book before publishing it. He compared the number of experiments in five seventh grade books. He found that one book had but twelve experiments while another for the same grade had fifty-six. In the eighth grade books one book had but eight experiments while another had seventy-five. In the ninth grade one book had thirty-one experiments while another had 186 experiments. He raised the question, "What is the right number of experiments to be given in any one grade?" Dr. Glenn felt that this condition resulted because the books were not written by teachers and that the authors had no conception of the amount that can or could best be given.

Dr. Glenn brought out the point that many teachers of general science have had no physics and yet 50% of the material in the general science books is in that field. Another point is—that in his state, and he felt it must be true in others—92% of the classes in general science are taught in rooms that have no equipment for experiments and that 52% of these rooms could not even be equipped as science rooms. In teacher training institutions no training is given in improvising equipment. He also mentioned that these teachers going out from school were unable to use the experiments given in the text books because the instructions were inadequate. He pointed out the range in number of lines given to directions in an experiment. They ranged from three lines to eighty-nine lines for a single experiment. There were so many revealing facts that it is impossible to adequately summarize Dr. Glenn's findings. Only enough has been given here to indicate that there is a problem regarding experiments so that those who were unable to be present at the convention could be aware of it and thus could probably help in the solution of it.

PAULINE ROYT, *Secretary*

BOOKS AND PAMPHLETS RECEIVED

TEXTBOOK OF BOTANY, by E. N. Transeau, *Professor of Botany, Ohio State University;* H. C. Sampson, *Professor of Botany, Ohio State University;* and L. H. Tiffany, *Professor of Botany, Northwestern University.* Cloth. Pages xi+812. 15.5×23 cm. 1940. Harper and Brothers, Publishers, 49 East 33rd Street, New York, N. Y. Price $4.00.

COLLEGE ALGEBRA, by Harold T. Davis, *Department of Mathematics, Northwestern University.* Cloth. Pages xiii+423. 14.5×23 cm. 1940. Prentice-Hall, Inc., 70 Fifth Avenue, New York, N. Y. Price $2.50.

NATURE RECREATION, by William Gould Vinal, *Professor of Nature Education, and Director of the Nature Guide School, Massachuesetts State College.* Cloth. Pages xi+322. 15×23 cm. 1940. McGraw-Hill Book Company, 330 West 42nd Street, New York, N. Y. Price $3.00.

AN INTRODUCTION TO COLLEGE GEOMETRY, by E. H. Taylor, *Head of the Department of Mathematics, Eastern Illinois State Teachers College, Charleston, Illinois,* and G. C. Bartoo, *Professor of Mathematics, Western State*

Teachers College, Kalamazoo, Michigan. Paper. 127+29 pages. 16×23 cm. 1939.

COFFERDAMS, by Lazarus White and Edmund Astley Prentis. Cloth. Pages xxiv+273. 15×23.5 cm. 1940. Columbia University Press, Morningside Heights, New York, N. Y. Price $7.50.

A PARTIAL LIST OF LATIN AMERICAN EDUCATIONAL JOURNALS. Paper. 25 pages. 21.5×28 cm. 1940. Divsion of Intellectual Cooperation, Pan American Union, Washington, D. C.

THE LAYMAN SCIENTIST IN PHILADELPHIA. A Directory of Amateur Scientists' Organizations and Resources in Science. W. Stephen Thomas, *Editor.* Paper. 44 pages. 15×23 cm. 1940. W. Stephen Thomas, *Executive Secretary, Committee on Education and Participation in Science, The American Philosophical Society,* 104 South 5th Street, Philadelphia, Pa. Price 15 cents.

MATHEMATICS INSTRUCTION IN THE UNIVERSITY HIGH SCHOOL, by Members of the Department of Mathematics of the University High School of the University of Chicago. Number 8, November 1940. Paper. Pages vii+184. 14.5×23 cm. The University of Chicago, Chicago, Ill. Price $1.00.

THE DOZEN SYSTEM, AN EASIER METHOD OF ARITHMETIC, by George S. Terry. Paper. 55 pages. 23×29 cm. 1941. Longmans Green and Company, New York, N. Y. Price 50 cents.

BOOK REVIEWS

COLLEGE PHYSICS, by John A. Eldridge, *Professor of Physics, University of Iowa.* Second Edition. Cloth. Pages xii+702. 13.5×21.5 cm. 1940. John Wiley and Sons, Inc., 440 Fourth Avenue, New York, N. Y. Price $3.75.

The first edition of this text, which appeared three-and-a-half years ago, was written to make physics interesting to the general student. It successfully combined the discoveries and theories of modern physics with the principles of classical physics. This revision holds very close to the original text but some material improvements have been made including numerous changes in the order of topics and the addition of much new subject matter. The chapter on elasticity, which caused considerable distress to both students and teachers now follows mechanics of fluids and has been re-written so as to eliminate most of the objections. Friction and centripetal force are given additional emphasis in a new chapter entitled "Examples of Forces." The division on wave motion and sound has been greatly improved by rearrangement of topics, revision of sentence structure, and the addition of new material. Other similar cases could be cited, but the greatest gain has been brought about by careful revision of certain important sentences such as the definition of the calorie (p. 239 new, p. 213 old), transforming an ambiguous inaccurate statement into a precise definition. Another very important improvement in the revised text has been effected by the addition of many new problems that are direct simple applications of the principles just discussed. The author has, however, followed the crowd by making his revised book nearly a hundred pages larger than the first edition. This creates an additional problem. Textbook writers and publishers should assume some responsibility for reduction in volume of subject mat-

ter by careful selection of basic essentials. This would tend to standardize courses in general physics, stimulate emphasis on reflective thinking, and reduce the cost to students.

G. W. W.

HANDBOOK OF CHEMISTRY AND PHYSICS. Twenty-fourth Edition. Editor, in Chief, Charles D. Hodgman, *Associate Professor of Physics at Case School of Applied Science;* Associate Editor, Harry N. Holmes, *Professor of Chemistry at Oberlin College.* Cloth. Pages xviii+2564. 11.5×18 cm. 1940. The Chemical Rubber Company, 1900 W. 112th Street, Cleveland, Ohio. Price $3.50.

Rapid development in physical science has again made necessary a revision of the *Handbook.* This time the new material mostly concerns organic compounds, plastics, and artificial radioactivity. More than three hundred new organic compounds have been added bringing the complete list above nine thousand. A tabular arrangement is now given. Particular attention is paid to the physical constants of these compounds that make them useful in industrial and manufacturing processes, such as specific gravity, melting and boiling points, flash point, solubility, uses, and source of supply. New plastics are listed with available data and new data on old plastics. Other new features include valuable data in the rapidly growing and popular field of photography, revised tables on foods and vitamins, and a new table on induced radioactivity. The circular of information states that 164 authorities representing 90 educational institutions and 21 industries collaborated in this new edition.

G. W. W.

A HISTORY OF CHEMISTRY, by F. J. Moore, *Late Professor of Organic Chemistry in Massachusetts Institute of Technology;* Revision Prepared by William T. Hall, *Associate Professor of Analytical Chemistry in the Massachusetts Institute of Technology.* Third Edition. Cloth. Pages xxi+447. 13.5×20.5 cm. 1939. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $3.00.

The two previous editions have been outstanding on the history of chemistry. The third edition has been so thoroughly revised that it is in reality a new book. In the previous edition little attention was paid to the work of living scientists. In this third edition the work of the prominent chemists in the various fields is discussed down to the present. More discussion on American Chemists and their work is in this edition than is given in other short histories of chemistry.

E. G. M.

LECTURE DEMONSTRATIONS IN GENERAL CHEMISTRY, by Paul Arthur, *Assistant Professor of General and Analytical Chemistry, Oklahoma Agricultural and Mechanical College.* Cloth. Pages xvi+455. 14×20.5 cm. 1939. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $4.00.

This book is a laboratory manual for the lecturer demonstrator. There are one hundred seventy-five experiments covering every phase of general chemistry. Many of the experiments are not discussed in text books of college chemistry. References are given at the end of each experiment. Most of the experiments can be performed with the usual laboratory equipment.

E. G. M.

INTERMEDIATE CHEMISTRY, by T. M. Lowry, *Professor of Physical Chemistry in the University of Cambridge*, and A. C. Cavell, *Senior Science Master at Uppingham School*. Second Edition. Cloth. Pages xvi+879. 13.5×21.5 cm. 1939. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $3.25.

The contents of this second edition are divided into seven parts. Part I. General and Theoretical. This part includes the atomic theory, chemical equivalents, molecular theory, determination of atomic and molecular weights, structure of matter, electronic theory of valency, formulae and equations, and classification of elements.

Part II. Typical Elements. This includes the inert gases, hydrogen, water, alkali metals, alkaline earths, boron, aluminium, carbon, silicon, tin, lead, nitrogen, phosphorus, arsenic, antimony, bismuth, oxygen, sulphur, and halogens.

Part III. Transitional Elements. The first chapter in this section contains a discussion on typical and transitional elements, their classification and properties.

Part IV. Analysis. This includes qualitative analysis of a pure substance, qualitative analysis of mixtures, volumetric analysis, gravimetric analysis, and organic analysis.

Part V. Physical Chemistry. This includes gaseous state, liquefaction and the liquid state, solid state, solutions, osmotic pressure, molecular weights in solution, the phase rule, thermochemistry, chemical equilibrium, velocity of chemical change, mechanism of chemical change, electrolysis and electrolytic dissociation, application to electrolysis of the law of mass action, and the colloidal state.

Part VI. Principles of Organic Chemistry. More discussion on organic compounds is given in this edition than is customary in other texts of general chemistry.

The discussions and diagrams of commercial processes are exceptionally good. The subject matter has been thoroughly revised and brought up to date. This edition is one of the outstanding texts in general chemistry.

E. G. M.

GENERAL PSYCHOLOGY, by Richard Wellington Husband, *Assistant Professor of Psychology, University of Wisconsin*. Cloth. Pages xiv+513. 15×23 cm. 1940. Farrar and Rinehart, Inc., New York, N. Y. Price $2.75.

The author has succeeded in making this textbook very interesting and worthwhile by illustrating the various topics with large numbers of practical life situations.

The subject is treated as a social rather than a biological science. The chapters: Practical Motivation, Acquisition and Control of Emotions, Development of Personality, and Deviations of Personality are especially good from the sociological standpoint in that they explain how an individual may use psychological principles in becoming a more acceptable and better adjusted member of society. The development of the subject follows the genetic point of view. This viewpoint is evident in the discussion of each general topic as well as in the sequence of the different chapters.

Detailed discussion of traditional topics such as the theories of vision and audition and the different schools of psychology are minimized or omitted. However, the majority of topics that are usually found in a general psychology course have been retained; they are presented in a practical manner. The text of the material is not burdened with specific citations of

psychological studies and experiments. The specific references together with general references for additional reading are listed at the end of each chapter.

This book is recommended for consideration as a textbook for general psychology classes and as a source of information for high school pupils and adults who are interested in the practical side of psychology.

LYLE F. STEWART

ELEMENTARY CALCULUS, by G. W. Caunt, M.A., M.Sc. *Late Reader in Mathematics at King's College, Newcastle-upon-Tyne.* Cloth. Pages 388. 12.5×18.5 cm. 1939. Oxford University Press, 114 Fifth Avenue, New York, N. Y. Price $2.75.

This interesting English text is written on the same lines as the author's *Introduction to the Infinitesimal Calculus.*

The customary arrangement of topics found in most American text books on Differential and Integral Calculus has been altered.

After an introductory chapter, the formulas for the derivatives of the algebraic and trigonometric functions are developed. This is followed by three chapters entitled: Geometrical Applications; Maxima and Minima; and Successive Integration.

The next chapter is devoted to simple integration of the algebraic and the trigonometric functions with applications.

The remaining material treated will be sufficiently indicated by the following list of chapter headings: Chapter IX, Convergency and Divergency. The Exponential Theorem; X, Differentiation of Exponential and Inverse Functions; XI, Methods of Integration; XII, Definite Integrals; XIII, Geometrical Applications; XIV, Polar Coordinates; XV, Centroids, Centres of Pressure, and Moments of Inertia; XVI, Curvature; XVII, Taylor's Theorem. There are answers to the odd exercises.

The treatment is unusual or different in a number of respects; two of them are the following. The derivative of the exponential function in Chapter X is obtained from its power series representation found in Chapter IX. Newton's method of determination of the approximate values of real roots of an equation is listed as a useful application of Taylor's theorem.

This book could be used as a text in American colleges.

RUTH B. RASMUSSEN
Wilson Junior College, Chicago

A BRIEF COURSE IN ANALYTICS, by M. A. Hill, Jr., and J. B. Linker, *University of North Carolina.* Cloth. Pages ix+204. 13×20 cm. 1940. Henry Holt and Company, 257 Fourth Avenue, New York, N. Y. Price $1.36.

The authors of this book have admirably achieved the aims set forth in the last paragraph of the preface which reads as follows: "The text is designed for classes which meet three hours a week, and the material has been so divided that illustrative examples and a set of exercises come at the end of each assignment. While none of the subject matter is new, the customary arrangement of certain topics has been altered in order to give greater unity to the course."

The reviewer liked especially well the treatment of Chapter II entitled Equations and Loci. Here the two fundamental problems of analytic geometry, namely, the concepts of the locus of an equation and the equation of a locus are so clearly set forth that the student can't miss them.

This chapter is unusual in the respect that the equations of translation appear at its end.

In Chapter III–V we find the usual geometry of the straight and the conic sections in rectangular coordinates. In Chapter VI entitled Equations in Other Forms are included sections on parametric equations, exponential and logarithmic curves, trigonometric curves, graphing by composition of ordinates, polar coordinates, plotting in polar coordinates, relations between polar and rectangular coordinates, and polar equations of the straight line and the conic sections.

On page 49 of this text appears the following inaccurate section heading: The Distance from a Line to a Point. Obviously, the heading should read "The Distance from a Point to a Line."

The color of the binding and the size and shape of the text are pleasing to the eye. The figures are well drawn. The topography is excellent.

RUTH B. RASMUSSEN
Wilson Junior College, Chicago

COLLEGE MATHEMATICS, A FIRST COURSE, by W. W. Elliott, *Professor of Mathematics and Director of Undergraduate Studies in Mathematics, Duke University*, and E. Roy Miles, *Assistant Professor of Mathematics, Duke University*. Cloth. Pages xiii+396. 15×23 cm. 1940. Prentice-Hall, Inc., 70 Fifth Avenue, New York, N. Y. Price $3.00.

The authors of this text make the following statement in the preface: "The purpose of this text is to present in one volume the essentials of college algebra and plane trigonometry and an introduction to plane analytic geometry and calculus.

The text contains the usual topics of college algebra including the following chapters: Progressions, Interest and Annuities, Permutations and Combinations, and Probability. Because of the inclusion of this material the text is also suitable for students interested in business administration, as well as for those interested in natural science.

The sections on trigonometry and analytic geometry contain the essentials but are very much more condensed than the one on algebra.

In the last section, the formulas for the differentiation and integration of the algebraic functions are developed. The usual applications of differential and integral calculus are made to these functions.

The Prentice-Hall Mathematical Tables chiefly to four places are bound separately and enclosed in a pocket on the back of the cover of the text. This text contains much more material than it seems to contain.

RUTH B. RASMUSSEN
Wilson Junior College, Chicago

TEXTBOOK OF BOTANY, by E. N. Transeau, *Professor of Botany, Ohio State University;* H. C. Sampson, *Professor of Botany, Ohio State University;* and L. H. Tiffany, *Professor of Botany, Northwestern University*. Cloth. Pages xi+812. 14.5×23 cm. 1940. Harper and Brothers, Publishers, 49 East 33rd Street, New York, N. Y. Price $4.00.

I predict that this *Textbook of Botany* will mark the beginning of a new phase of the teaching of general botany. Here the plant appears as it really is—a living organism. The plant's significance to all mankind is so ably pointed out that the students' appreciation for the whole field of botany is intensified immensely. High school teachers will find it indispensable as a reference book. Its 424 photographs and figures (practically all orginal) illustrate numerous interesting experiments which may be performed in

laboratories which are limited in equipment. Many of the pictures are photomicrographs of the various parts of plants. This feature alone sets a new high for the morphological phase of a general botany textbook. Chapter VI (Points of View in Interpretation of Plant Behavior) will suggest to any teacher enough ideas to keep a class intensely interested in every phenomenon found in living organisms. As a matter of fact, some authors of recent biological textbooks would find the chapter excitingly new.

The book includes a discussion of "soil-less farming," "the dust bowl," "hormones," and other present popular subjects in the field of botany. Citations of scientific papers published in 1939 and 1940 are found throughout the book. Few textbooks of general botany have ever appeared which give such an excellent account of the vegetational pattern of North America. It gives not only a description, numerous photographs, and a map of the vegetation in the various parts of the continent, but many of the factors responsible for this vegetational pattern are discussed in logical sequence. Its full color plates set a new standard for illustrations and its approach to the whole field of botany sets a new standard for general botany textbooks. Perhaps its best feature is that students can understand it.

GLENN C. COUCH
The University of Oklahoma

A COURSE OF ANALYSIS, by E. G. Phillips, M.A., M.Sc., *Senior Lecturer in Mathematics in the University College of North Wales, Bangor; formerly Senior Scholar of Trinity College, Cambridge.* Cloth. Pages viii+361. 14×22 cm. 1939. Cambridge: at The University Press. New York: The Macmillan Company. Price $4.00.

The material covered includes much that might be included in an American text on advanced calculus or theory of functions of real variables. It is assumed that the reader is familiar with the usual treatment in elementary texts on the calculus, although in a very large number of places footnotes suggest such texts which might be consulted. On the other hand there are also many footnotes making references to material which the author did not find elementary enough to be within the scope of the present work.

The author states that the content of the book is intended to be a first introduction of the student to rigorous analysis. Much of the material would no doubt be suitable for an advanced undergraduate course or a graduate course. Many college teachers will appreciate the many places in which the author points out the lack of rigorous treatment in elementary texts.

Examples which are found at the end of the chapters are in several cases quite elementary, in other cases quite the converse is true.

CECIL B. READ
University of Wichita

STATISTICAL PROCEDURES AND THEIR MATHEMATICAL BASES, by Charles C. Peters, Ph.D., *Director of Educational Research, The Pennsylvania State College,* and Walter R. Van Voorhis, M.A., *Schuylkill Administrative Head and Assistant Professor of Mathematics, The Pennsylvania State College.* Cloth. Pages xiii+516.15×23 cm. 1940. McGraw-Hill Book Company, Inc., New York. Price $4.50.

This is a revision and extension of an earlier lithoprinted edition. At several points, however, limitations of space have made it necessary to refer to the first edition for full details of a development. The book starts with a chapter devoted to calculus, written for the person who has had no previous contact with the subject.

The authors make no claim to give a comprehensive treatment of the mathematical bases of statistics but very definitely go much farther than the usual elementary book. Even with the introductory chapter and a definite attempt to supply many steps frequently omitted in mathematical texts, the reader untrained in mathematics may find some parts not easy reading.

It is gratifying to note that the authors emphasize formulas which are adapted to computing machines. Illustrative material is taken from actual research studies in the fields of education and psychology; in fact these words might appear in the title. References for further reading frequently include original contributions to the development of the topic under consideration.

The general appearance of the book is excellent. No typographical errors were noted; what is apparently an unusual notation for the second and higher derivative, as found on pages 14, 27, and 28, is not used consistently, see page 295 for example.

This should be an excellent text for an advanced course in statistics, it should likewise be a splendid reference work for the research worker.

CECIL B. READ
University of Wichita

MANY-VALUED LOGICS*

PROFESSOR J. BARKLEY ROSSER, *Cornell University, Ithaca, N. Y.*

Seven years ago a physicist, Dr. F. Zwicky of California Institute of Technology, declared that he thought it would be easier to explain the atom if he could use a many-valued logic instead of the usual two-valued logic. By a many-valued logic, he meant one which denies the principle of reductio ad absurdum. This principle of reductio ad absurdum went unchallenged for centuries, during which everyone believed that a precise and clear-cut statement is either so or not so. A many-valued logic denies this, and states that instead of the two possibilities "so" and "not so," there are n possibilities.

What are these possibilities? Who can say? They are simply called "possibility one," "possibility two," etc. When n is small, there might be a chance of saying what the possibilities are. For instance, when n is three the possibilities might be "so," "not so," and "undecidable." When n is six, the possibilities might be "certainly so," "probably so," "possibly so," "possibly not so," "probably not so," and "certainly not so." One often answers questions with a "certainly" or a "possibly not" or the like. However, questions which can be answered in such a way have always dealt with realms where the phenomena are vague. A general question such as "Do you favor short skirts for women?" might well receive six answers varying from "certainly" to "certainly not." However, the fundamental tenet of a many-valued logic is that not only general questions, but even the most precise and clear-cut statement may fall into any one of n possible cases.

Before Dr. Zwicky's suggestion, a many-valued logic had been considered by mathematicians as rather an interesting game, but hardly worth intensive study. However, Dr. Zwicky seriously requested that mathematicians get busy and develop many-valued logics for use in explaining the atom, and since that time some systematic work has been done on the problem. This work was reported on before the American Mathematical Society,

* Abstract of an address delivered before the American Mathematical Society, at Wayne University, Detroit, Michigan, November 22, 1940.

meeting at Wayne University, Detroit, Michigan, by Professor J. Barkley Rosser of Cornell University, who told of results that he and others had obtained.

The principal result so far is that a many-valued logic turns out to be much more complicated than anyone had expected. The reason for this is that the meaning of every mathematical word depends on the fact that one uses a two-valued logic for ordinary mathematics. Allow more values, and you get more meanings for every word. What nobody had suspected was that you get a great many more meanings for every word. In a three-valued logic, there are 256 distinct meanings of the simple word "and." In a four-valued logic there are 14,348,907 distinct meanings of "and." And so on. All this complication makes things hard for the mathematician, but allows more freedom for the physicist. Imagine how many possible kinds of atoms a physicist could make out of electrons AND protons with 256 kinds of "and" to choose from, and how much more chance he'd have of finding one that worked the way it ought to.

COLCHICINE EXPERIMENTERS WARNED OF POSSIBLE DANGERS TO SELVES

Colchicine, the "magic drug" that speeds up evolutionary processes in plants by doubling chromosome numbers, may be dangerous if not handled with proper precautions, Dr. Haig Dermen of the U. S. Department of Agriculture warns the hundreds of enthusiastic amateur experimenters now engaged in trying to produce strange and possibly valuable new varieties.

Animal tissue is much more sensitive than plant, to the effects of colchicine, states Dr. Dermen. A minute quantity of the solution, of the concentrations used on plants, might cause blindness if it got into a person's eye, or might produce skin irritation if carried to the face.

Up to the present at least, colchicine has had no scientifically valuable effects when used in attempts at producing new varieties of animals. Most of the experiments on animal cells simply resulted in the death of the cells. There have recently been some reports of modifications of the colchicine treatment, using much weaker solutions that may have induced chromosome doubling in animals without killing the cells. However, to date the outcome of these experiments has been so equivocal that for persons desiring dependable and practical results work with plants continues to be much more promising.

RADIUM AND X-RAY TREATMENT REPORTED SUCCESSFUL IN BRAIN TUMORS

Brain tumors can be successfully and safely treated by large doses of radium or X-rays, Dr. Ira L. Kaplan, of Bellevue Hospital and New York University, reported at the meeting of the Radiological Society of North America.

New Knowledge of radiation treatment, Dr. Kaplan said, enables physicians to use larger, and therefore more effective, doses than they dared to use in the past when it was feared such doses might harm the brain tissue as well as destroying the tumor.

In most cases, he said, radiation treatment should follow surgical treatment, but in some cases irradiation alone produces the desired results.

COMMENT ON "TEACHING MATHEMATICAL INDUCTION"

W. C. KRATHWOHL, *Illinois Institute of Technology, Chicago, Ill.*

The article "Teaching Mathematical Induction" by Merton Taylor Goodrich in the May 1940 number of SCHOOL SCIENCE AND MATHEMATICS contains a very serious error of logic on pages 475 and 476. The author, wishing to prove that two expressions are identities, first sets them equal to each other, then performs identical operations on both members of the equation and reduces them to an obvious identity. From this he concludes that the original expression is an identity.

That this method is fallacious can be shown by proving $1=2$. Let us, as the author does, assume that $1=2$. Next subtract $1\frac{1}{2}$ from both members of the equation. This gives $-\frac{1}{2}=\frac{1}{2}$. Now square both members of this equation and get $\frac{1}{4}=\frac{1}{4}$, which obviously is an identity. If now we follow the line of reasoning of the author we must conclude that the equality $\frac{1}{4}=\frac{1}{4}$ implies that 1 must equal 2.

What the author has done is to use the old fallacy of assuming one's conclusion. Anyone who has taught geometry can give many examples of false statements which can be proved to be true by this method.

REPLY

MERTON T. GOODRICH, *State Teachers College, Keene, N. H.*

It appears that Professor Krathwohl has confused the procedures of certain mathematical recreations with mathematical reasoning. In the illustration which he gives he has made the error which often appears in those amusing trick problems. When he reaches $-\frac{1}{2}=\frac{1}{2}$ he makes the mistake of squaring both sides of the equation. This is really multiplying the left side by $-\frac{1}{2}$ and the right side by $+\frac{1}{2}$, which is an incorrect step; because both sides of an equation (whether true or hypothetical) must be multiplied by the same constant with the same sign or else the relationship is changed. The statement $\frac{1}{4}=\frac{1}{4}$ was therefore not obtained by a correct mathematical step. A similar false step occurs in many of the "proofs" so called, to which Professor Krathwohl refers. If he had taken correct mathematical steps, the results $+\frac{1}{4}=-\frac{1}{4}$ or $-\frac{1}{4}=+\frac{1}{4}$ would have been obtained, and this sort of thing could be continued indefinitely as long as correct steps were taken proving his first assumption false not true.

This point should be remembered. It is permissible as a correct mathematical procedure to square both sides of an equation only when this step is equivalent to multiplying both sides of the equation by the same quantity with the same sign, and if this quantity contains the variable the extraneous roots thus introduced must be stricken out of the solution.

Of course, in any proof, an assumption and statements derived from it can not be used as mathematical steps until after they have been established. This procedure is frequent in certain types of mathematical puzzles. On the other hand, the operations performed upon the hypothetical equations or assumptions in my method of teaching Mathematical Induction are independent of the assumptions and consequently are logical steps in the proofs.

If an assumption is made and correct mathematical procedures are followed reducing that assumption to a contradiction, the assumptio has been proved false. On the other hand, if an assumption is made and correct mathematical procedures are followed leading to a known truth, the assumption is proved true. This is not an old fallacy as Professor Krathwohl asserts but a very old and very sound method of proof. But if a person starts out with an assumption, true or false, and takes incorrect or unestablished steps, what have you?

USE OF FOREST CUTTINGS NOW WASTED SEEN AS AID TO CONSERVATION PROGRAM

Forest cuttings now wasted can be used in new kinds of wood stoves that will operate for many hours without attention. Such use can be made an important aid to conservation, L. E. Seeley and F. W. Keator, of Yale University, said at a session of the fuels division of the American Society of Mechanical Engineers.

They emphasized the importance of "space heaters." These are small units for home use to heat the room in which they are installed, and adjacent rooms through the movement of air through communicating doorways. This arrangement, they said, is used in about 45% of one- and two-family homes in cities and is even more widely employed in the country.

When forests are cut for timber, it was stated, "30 to 40% of the wood, constituting the branches and trimmings, is useless as timber." Use of this for heating would aid greatly in efficient maintenance of the forests.

In the new types of heaters, described by the speakers, the burning is only at the bottom of the pile after they have been started. The heat, however, converts the upper wood into charcoal. As ashes drop through the grate into the pit below, fresh charcoal is automatically fed to the burning zone.

The heater requires attention only occasionally, to refill the wood reservoir. The ashes are removed every few days.

Adventuring in Science

Powers
•
Neuner
•
Bruner
•
Bradley

In striking new books, a progressive course for grades seven, eight, and nine. Offering a *real* adventure in science, the series takes pupils on new explorations of the fascinating world around them. Clear, readable, logically developed, scientifically accurate, with an abundance of vital exercise material, and meeting the leading recommendations in the field.

Book I, EXPLORING OUR WORLD; Book II, OUR WORLD CHANGES; *and now*, carrying to completion the objectives of the course, Book III, USING OUR WORLD. Each volume beautifully illustrated. Workbooks of Directed Activities are available.

GINN AND COMPANY

Boston New York Chicago Atlanta Dallas Columbus San Francisco

Let us continually hold before our young the vision of a better America and a better world, a world in which mercy is coupled with justice, a world of love and not hatred.

—NORTON A. KENT

CONTENTS FOR FEBRUARY, 1941

Some Desirable Curriculum Adjustments in Science and Mathematics—*Walter H. Carnahan* 103

The Determination of Molecular Dimensions by the Oil Film Method—*John Laughlin* 115

Modern Technics in First Aid—*Eugenia Couden* 119

Cold Light in the Home—*Leroy D. Johnson* 123

Diagnosis and Remedial Instruction in Mathematics—*R. B. Thompson* 125

Does the Law $\sqrt{a} \cdot \sqrt{b} = \sqrt{ab}$ Hold for Imaginary Numbers? Does It Hold at All?—*Michael A. Sadowsky* 128

Powdered Metals in Modern Life—*Robert Steinman* 131

Microfilm Equipment for the Individual Worker—*Herman Branson* 140

A High School Chemistry Course Based on the Principles of Reflective Thinking—*Arthur L. Mills* 144

The Law of Tangents in Modified Form and Some Other Related Formulas—*Jacob M. Kinney* 158

Unexplored Possibilities of Instruction in Graphic Methods—*William L. Schaaf* 160

The Plight of High School Physics. VII. Public Relations—*H. Emmett Brown* 171

A Note on Parametric Equations—*Cecil B. Read* 178

Automatic Headlight Control for Automobiles—*Benj. Johnson* 179

Professor N. Henry Black Honored—*Burton L. Cushing* 180

Eastern Association of Physics Teachers. One Hundred Forty-Sixth Meeting—*Carl W. Staples* 181

- Address of Welcome—*Norton A. Kent* 181
- Memorandum About John C. Packard 186
- Report of the Apparatus Committee 186
- Address: Seismology and Its Applications—*Daniel Linehan* 188

Problem Department—*G. H. Jamison* 194

Science Questions—*Franklin T. Jones* 200

ESSAYS ON THE NEW VORTEX ATOM

by Carl F. Krafft

A new geometric system of atomic structure based upon the quasifrictional dynamic ether of Clerk Maxwell.

CONTENTS: Inert Gas Atoms; Fundamentals of the New Vortex-Atom Theory; Protons, Electrons, and Neutrons; Hydrogen and Helium; Vortex-Atom Structures from Lithium to Neon; Valence-Bonds, Solubility, and Wettability; Orthohydrogen and Parahydrogen; Atomic Oscillators; The Splitting of the Uranium Atom.

Free upon request

C. F. Krafft, 2510 Q St., N.W., Wash., D.C.

OVER 500

high schools and colleges use it

"The INTERVIEW METHOD of Teaching Qualitative Analysis"

● A Self-Running Book

Just the thing to keep superior students busy. Price $1.00. Money refunded if not satisfied.

Please address Professor Ewing

Wesleyan College, Fort Worth, Texas

The Easiest QA in Print

Third Edition of

AMERICAN PLANT NAMES

By WILLARD N. CLUTE

This is the second addition to the first edition, making a total of 12,000 common names arranged under their correct technical equivalents. No reference library should be without it.

286 pages—$3.00 postpaid

Common Names of Plants ($3) and Second Book of Plant Names ($3) give the meanings of a large number of these names.

WILLARD N. CLUTE & CO.

Indianapolis, Ind.

SCHOOL SCIENCE and MATHEMATICS

ANNOUNCES

the best new books and apparatus each month

READ THE ADVERTISEMENTS

SCIENCE IN MODERN LIVING SERIES

Prepared by the Bureau of Educational Research in Science of Teachers College, Columbia University

Valuable teaching material, designed especially to relate science to problems of modern living. Each volume deals with social and economic aspects of some phase of contemporary science.

LIFE AND ENVIRONMENT. An interpretation of situations and problems arising out of the interrelations between human society and its living and non-living environment. By PAUL B. SEARS, Professor of Botany, Oberlin College. 175 pp. Cloth $1.85.

THE STOREHOUSE OF CIVILIZATION. An account of the role of the earth's materials in shaping our modern civilization. Contains industrial and technological facts that are invaluable to students of everyday living. By C. C. FURNAS, Associate Professor of Chemical Engineering, Yale University. 562 pp. Illus. Cloth $3.25.

THE CONTROL OF ORGANISMS. The story of man's efforts to dominate and control undesirable organic factors of his environment. Calls for an awakened consciousness of the problems of overcoming these natural enemies and competitors. By FREDERICK L. FITZPATRICK, Professor of Natural Sciences, Teachers College, Columbia University. 336 pp. Illus. Cloth $2.75.

SCIENCE EDUCATION IN CONSUMER BUYING. By GEORGE L. BUSH. In press.

GENES AND THE MAN. By H. BENTLEY GLASS. In press.

SUGGESTIONS FOR TEACHING

SELECTED MATERIAL FROM THE FIELD OF GENETICS. By ANITA D. LATON, EDNA W. BAILEY and others. 66 pp. Paper 50 cents.

SELECTED MATERIAL FROM THE FIELD OF SEX RESPONSIVENESS, MATING AND REPRODUCTION. By ANITA D. LATON and EDNA W. BAILEY. 118 pp. Cloth $1.35. Paper 75 cents.

BUREAU OF PUBLICATIONS

Teachers College, Columbia University

New York City